Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., F.R.Met.Soc., and E. S. GREW, M.A.

VOL. V. No. 9. [NEW SERIES.] SEPTEMBER, 1908. [Entered at Stationers' Hall.] SIXPENCE NET.

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Some Astronomical Facts and Fallacies.

By J. E. GORE, F.R.A.S., M.R.I.A.

THE following astronomical facts and fallacies, which I have collected from various sources, are not usually mentioned in books on astronomy, and may prove of interest to the general reader.

It is mentioned in the "Anglo-Saxon Chronicle" that a total eclipse of the sun took place in the year after King Alfred's great battle with the Danes. Now, calculation shows that this eclipse occurred on October 29, 878 A.D. King Alfred's victory over the Danes must therefore have taken place in A.D. 877, and his death probably occurred in A.D. 899. This solar eclipse is also mentioned in the "Annals of Ulster."

It is stated by many historians that an eclipse of the sun took place on the morning of the battle of Crecy, August 26, 1346. But calculation shows that there was no eclipse of the sun visible in England in that year. At the time of the battle the moon had just entered on her first quarter, and she was partially eclipsed six days afterwards, on the 1st of September. The mistake seems to have arisen from a mistranslation of the old French word *esclistre*, which means lightning. This was mistaken for *esclipse*. The account seems to indicate that there was a very heavy thunderstorm on the morning of the famous battle.

A dark shade was seen on the waning moon by Messrs. Hirst and J. C. Russell on October 21, 1878, "as dark as the shadow during an eclipse of the moon."* If this observation is correct it is certainly most difficult to explain. Another curious observation is recorded by Mr. E. Stone Wiggins, who says that a partial eclipse of the sun by a dark body was observed in the State of Michigan (U.S.A.) on May 16, 1884, at 7 p.m. The "moon at that moment was 12 degrees south of the equator, and the sun as many degrees north of it." The existence of a dark satellite of the earth is suggestel, but this seems highly improbable.

Investigations on ancient eclipses of the moon show that the eclipse mentioned by Josephus as having occurred before the death of Herod is probably that which took place on September 15, B.C. 5. This occurred about 9.45 p.m., and probably about 6 months before the death of Herod (St. Matthew II., 15).

Kepler states in his *Somnium* that he saw the moon in thin crescent phase on the morning and evening of the *same* day (that is, before and after conjunction with the sun). Kepler could see 14 stars in the Pleiades with the naked eye, so his eyesight must have been exceptionally keen.

The "moon maiden" is a term applied to a fancied resemblance of a portion of the Sinus Iridum to a female head. It forms the "promontory" known as Cape Heraclides, and may be looked for when the moon's "age" is about 11 days. Mr. C. J. Caswell, who observed it on September 29, 1895, describes it as resembling "a beautiful silver statuette of a graceful female figure with flowing hair."

It has been stated that the moon as seen with the highest powers of the great Yerkes telescope appears "just as it would be seen with the naked eye if it were suspended sixty miles over our heads." But this statement is quite inaccurate. The moon as seen with the naked eye, or in a telescope, shows us nearly a whole hemisphere of its surface. But were the eye placed only 60 miles from its surface we should see only a small portion of its visible hemisphere. In fact, it is a curious paradox that the nearer the eye is to a sphere the less we see of its surface! The truth of this will be evident from the fact that on a level plane an eye placed at a height of, say, 5 feet sees a very small portion of the earth's surface indeed, and the higher we ascend the more of the surface we see. I find that at a distance of 60 miles from the moon's surface we should only see a small fraction of its visible hemisphere (about $\frac{1}{10}$th). The lunar features would also appear under a different aspect. The view would be more of a landscape than that seen in any telescope. This view of the matter is not new. It has been previously pointed out, especially by M. Flammarion and Mr. Whitmell, but its truth is not, I think, generally recognised. Professor Newcomb doubts whether with any telescope the moon has ever been seen so well as it would be if brought within 500 miles of the earth.

From careful observations of the Zodiacal Light, Mr. Gavin J. Burns finds that its luminosity is only "some 40 to 50 per cent. brighter than the background of the sky. Professor Newcomb has made a precisely similar remark about the luminosity of the Milky Way, viz.: that it is surprisingly small." This agrees with my own observations during many years. It is only on the finest and clearest nights that the Milky Way forms a conspicuous object in the night sky. And this only in the country. The lights of a city almost obliterate it. Mr. Burns finds that the Zodiacal Light appears "to be of a yellowish tint; or if we call it white, then the Milky Way is comparatively of a bluish tint." During my residence in the Punjab, the Zodiacal Light seemed to me constantly visible in the evening sky in the spring months. In the West of Ireland I have seen it nearly as bright as the brighter portions of the Milky Way (February 20, 1890). The "meteoric theory" of the light seems to be the one now generally accepted by astronomers, and in this opinion I fully concur.

* *The Observatory*, vol. ii., p. 375.

XUM

From observations of the "Gegenschein," or Zodiacal Counter Glow, Professor E. E. Barnard finds that it is not so faint as is generally supposed. "It is best seen by averted vision, the face being turned 60° or 70° to the right or left, and the eyes alone turned towards it. It is invisible in June and December, while in September it is round, with a diameter of 20°, and very distinct." No satisfactory theory has been advanced to account for this curious phenomenon. Professor Arthur Seale, of Harvard, attributes it to a number of asteroids too small to be seen individually. In "opposition" these would be fully illuminated and nearest to the earth. Its distance from the earth probably exceeds that of the moon. Dr. Johnstone Stoney thinks that the Gegenschein may possibly be due to a "tail" of hydrogen and helium molecules repelled from the earth by solar action. This "tail" would be visible to us by reflected sunlight. There seems to be "a slight lagging of the Gegenschein behind the anti-solar position," and this would agree with Stoney's theory.

The rotation period of the planet Venus seems to be still uncertain. A slow rotation of about 225 days is favoured by Perrotin, Schiaparelli, and Terby, while Neisten, Stuyvaert, Trouvelot and Leo Brenner support De Vico's old period of about 24 hours.

Projections on the limb of the planet Mars have frequently been observed in America. These are known not to be mountains, as they do not re-appear under similar conditions. They are supposed to be clouds, and one seen in December, 1900, has been explained as a cloud lying at a height of some 13 miles above the surface of the planet and drifting at the rate of about 27 miles an hour. Recent spectroscopic observations at Mr. Lowell's Observatory have proved the existence of water vapour in the atmosphere of Mars. If there are any mountains on Mars they have not yet been discovered. The existence of the so-called "canals" is supposed to be confirmed by Lowell's photographs of the planet; but what these "canals" really represent, that is the question. They have certainly an artificial *look* about them, and they form one of the most curious problems in the heavens. The late Mr. Proctor thought that Mars is "far the reddest star in the heavens; Aldebaran and Antares are pale beside him."* But this does not agree with my experience. Antares is, to my eye, quite as red as Mars, and the colour of Aldebaran is quite comparable with that of the "ruddy planet." In the telescope, the colour of Mars is, I believe, more yellow than red, but I have not seen the planet very often in a telescope. Sir John Herschel suggested that the reddish colour of Mars may possibly be due to red rocks, like those of the old red sandstone, and the red soil often associated with such rocks, as I have myself noticed near Torquay and other places in Devonshire.

From observations of Uranus made in 1896, Mr. Leo Brenner concluded that the planet rotates on its axis in about 8½ hours (probably 8h. 27m.).

The existence of a second satellite of Neptune is suspected by Professor Schaeberle, who thinks he saw it with the 36-inch telescope of the Lick Observatory "on an exceptionally fine night in 1895."† But this supposed discovery has not yet been confirmed.

It has often been stated that the old Indian emperor Jehangir "had a sword made from a piece of meteoric iron which fell in the Punjab in the year 1620." According to Sir M. E. Grant Duff, President Diaz, of Mexico, had a sword made from an aerolite.*

Many attempts have been made by "paradoxers" to show that the earth is a flat plane and not a sphere. But M. Ricco has found by actual experiment that the reflected image of the setting sun, seen from a smooth sea, is an elongated ellipse. This proves mathematically beyond all doubt that the surface of the sea is spherical; for the reflection from a plane surface would be *circular*. The theory of a "flat earth" is, therefore, proved to be quite untenable, and all the arguments (?) of the "earth flatteners" have now been "blown into space."

With reference to the apparent enlargement of celestial bodies near the horizon, M. Paul Stroobant finds that if G is the size of an object at a certain altitude H, then the formula G = 100 – 19 Sin H represents very well the relation between G and H. if we take 100 as the size on the horizon.† For an object in the zenith this would give G = 81.

Mr. Denning thinks that on the return of Halley's comet in 1910, there may possibly be a shower of meteors on about May 4 of that year, "when the earth reaches that part of its orbit corresponding with the descending node of the comet," the earth being then distant about 5½ millions of miles from the comet's orbit.‡

In the Sanscrit epic poem, the "Ramayana," it is stated that at the birth of Rama, the moon was in Cancer, the sun in Aries, Mercury in Taurus, Venus in Pisces, Mars in Capricornus, Jupiter in Cancer, and Saturn in Libra. Mr. Walter R. Old has computed that the corresponding date is February 10, 1761 B.C.§

The late Mr. Proctor and Professor Young believed "that the contraction theory of the sun's heat is the true and only available theory." The theory is, of course, a sound one, but it may now be supplemented by supposing the sun to contain a certain small amount of radium. This would bring physics and geology into harmony. Proctor thought that the "sun's real globe is very much smaller than the globe we see. In other words, the process of contraction has gone on further than, judging from the sun's apparent size, we should suppose it to have done, and, therefore, represents more sun work" done in past ages. The truth of this idea seems very probable.

With reference to the nebular hypothesis, Dr. A. R. Wallace argues that "if there exists a sun in the state of expansion in which our sun was when it extended to the orbit of Neptune it would, even with a parallax of $\frac{1}{60}$th of a second, show a disc of half-a-second, which could be seen with the Lick telescope." My reply to this is, that with such an expansion there would probably be very little intrinsic luminosity, and if luminous enough to be visible, the spectrum would be that of a gaseous nebula, and no known *star* gives such a spectrum. But some planetary nebula look like small stars, and with a high power would probably show a disc. On these considerations, Dr. Wallace's objection does not seem to be valid.

It is a popular idea that stars may be seen in the daytime from the bottom of a deep pit or high chimney. But this is not the case, and has been often disproved. Stars may, however, be seen in the daytime with even small telescopes. It is said that a telescope

* "KNOWLEDGE," May 2, 1886. † *Journal*, B.A.A., June, 1895.

* *Journal*, B.A.A., July, 1903. † *The Observatory*, No. 104, 1885.
‡ *Journal*, B.A.A., No. 4, vol. xii. § *Nature*, Nov. 2, 1893.

of one-inch aperture will show stars of the second aperture, like those in the "belt" of Orion, or the brighter stars of the "Plough"; of two inches, stars of the third magnitude; and of four inches, those of the fourth magnitude. But I cannot confirm this from personal observation. It may be so, but I have not tried the experiment.

The photographic method of charting the stars, although a great improvement on the old system, seems to have its disadvantages. One of these is that the star images are liable to disappear from the plates in the course of time. The reduction of stellar photograph plates should therefore be carried out as soon as possible after they are taken. Dr. Roberts found that on a plate originally containing 364 stars, no less than 130 had completely disappeared in 9¼ years.*

It has been assumed by some writers on astronomy that the faint stars visible on photographs of the Pleiades are at practically the same distance from the earth as the brighter stars of the cluster, and that consequently there must be an enormous difference in actual size between the brighter and fainter stars. But there is really no warrant for any such assumption. Photographs of the vicinity show that the sky all round the Pleiades is equally rich in faint stars. It seems, therefore, more reasonable to suppose that most of the faint stars visible in the Pleiades are really far behind the cluster in space. For if *all* the faint stars visible on photographs belonged to the cluster, then if we imagine the cluster removed, a "hole" would be left in the sky, which is, of course, utterly improbable. An examination of the proper motions tends to confirm this view of the matter, and indicates that the Pleiades cluster is a comparatively small one and projected on a background of fainter stars.

It has long been suspected that the famous star 61 Cygni, which is a double star, is a binary system, that is, that the two stars composing it revolve round their common centre of gravity, and move through space together. But measures of parallax made by Hermann S. Davis and Wilsing seem to show a difference of parallax between the two components of about 0.08 of a second of arc. This difference of parallax implies a distance of about 2¼ "light-years" between the two stars, and "if this is correct, the stars are too remote to form a binary system. The proper motions of 5″.21 and 5″.15 seem to show that they are moving in nearly parallel directions, but are probably slowly separating." Mr. Lewis, however, thinks that a physical connection probably exists.†

From an examination of the heat radiated by some bright stars made by Dr. E. F. Nicholls in America, with a very sensitive radiometer of his own construction, he found that "we do not receive from Arcturus more heat than we should from a candle at a distance of five or six miles."

From a comparison of Trouvelot's drawing of the small elongated nebula near the great nebula in Andromeda with recent photographs, Mr. Easton infers that this small nebula has probably rotated through an angle of about 15° in 25 years. An examination I have made of photographs taken in different years seems to me to confirm this suspicion, which, if true, is evidently a most interesting phenomenon.

Keeler, Vogel, and Eberhard found that the great Orion nebula is apparently receding from the earth at the rate of about 11 miles a second. As this is about the sun's computed velocity through space in the opposite direction, the nebula is probably at rest. Keeler thought "that a nebula of such vast extent and tenuity is more likely to be at rest relatively to the stars of our system than small compact nebular masses or individual stars."

Ptolemy, in his description of the Milky Way, given in the "Almagest," says nothing whatever of the bright region in Scutum. This is probably due to an omission of the copyists, as it seems impossible to suppose that Ptolemy did not see this remarkable spot.

Easton calls the Milky Way "the most strange and most amazing of optical errors." But I presume he does not suppose the Galaxy to be merely an optical illusion, for the telescope shows that its objective existence is beyond a doubt.

About the middle of September, 1878, Mr. Greely, of Boston (U.S.A.), reported to Mr. E. F. Sawyer (the eminent observer of variable stars) that about the middle of August of that year he had seen the famous variable star, Mira Ceti, of about the second magnitude, although the star did not attain its usual maximum until early in October, 1878. Mr. Greely stated that several nights after he first saw Mira it had faded to 4th or 5th magnitude. If there was no mistake in this observation (and Sawyer could find none) it was quite a unique phenomenon, as nothing of the sort has been observed before or since in the history of this famous star. It looks as if Mr. Greely had observed a new or "temporary" star near the place of Mira Ceti, but as the spot is far from the Milky Way, which is the usual seat of such phenomena, this hypothesis seems improbable.

Dante speaks of the four bright stars in the well-known "Southern Cross" as emblematical of the four cardinal virtues, Justice, Temperance, Fortitude, and Prudence; and he seems to refer to the stars Canopus, Achernar, and Fomalhaut, under the symbols of Faith, Hope, and Charity. The so-called "False Cross" is said to be formed by the stars, κ, δ, ε and ι, of the constellation Argo Navis. But it seems to me that a better (although larger) cross is formed by the stars α Centauri, and α, β, and γ, of Triangulum Australis.

Mr. Monck has pointed out that the names of the brightest stars in the Northern hemisphere seem to be arranged alphabetically, in order of colour, beginning with red, and ending with blue. Thus we have Aldebaran, Arcturus, Betelgeuse, Capella, Procyon, Regulus, Rigel, Sirius, Spica, and Vega. But as the origin of the names is different this must be merely a curious coincidence.* And, to my eye at least, Betelgeuse is redder than Arcturus.

Some interesting observations made recently by Professor W. H. Pickering, in Jamaica, make the value of sunlight 540,000 times moonlight. This makes the sun's stellar magnitude to be — 26.83, and that of full moonlight — 12.5. Professor Pickering finds that the light of the full moon is equal to 100,000 stars of zero magnitude. He finds that the moon's "albedo" is about 0.9909; or, in other words, that the moon reflects about one-tenth of the light which falls on it from the sun. He also finds that the light of the full moon is about 12 times the light of the half moon; a remarkable and rather a startling result.†

Journal, B.A.A., October, 1895. †*Journal*, B.A.A., February, 1898.

* *The Observatory*, April, 1887.
† Annals of Harvard College, vol. xli., part i., 1908.

XUM

Photo-micrography as an Aid to the Study of Cell-problems.

By H. A. HAIG, M.B., M.R.C.S.

IN obtaining records of cytological investigations it is always essential to ensure permanent and at the same time accurate means whereby even the minutest details are brought out, and the photographic plate is, perhaps, one of the surest and most accurate recorders we possess nowadays for the delineation of microscopical details. Moreover, good results may be obtained with comparatively simple apparatus, provided always that the microscope used be a good one, especially as far as objectives are concerned, and the stains used in the preparation of objects of such a nature as to produce the maximum actinic effect upon a photographic film; for it has been found that some stains such as Bismarck brown, safranin, and some others have by far the best effect in this respect. In selecting nuclear division for the demonstration of the advantages of photo-micrography, the object will be in the present article to attempt to explain some of the ways in which fair results may be obtained in this notoriously difficult and delicate branch of cytology. I say "fair" results for the reason that to obtain the best involves the employment of apparatus too elaborate for the attainment of most workers at the subject. With care, however, and with averagely good apparatus, we may hope at least to elucidate some of the main stages in the process of mitosis. I have also included some plant-embryology.

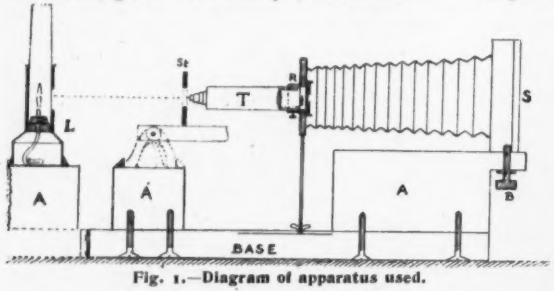


Fig. 1.—Diagram of apparatus used.

Fig. 2.—The embryo-sac of Lilium at the beginning of the first nuclear division.

A brief description of the apparatus used is here necessary. The essential point about it is that rigidity shall be ensured by the employment of a firm, heavy base-board of mahogany 3 ft. in length, 2 ins. thick, and 6 ins. in width (see diagram). To this are screwed two mahogany blocks A, the hindmost of which has a projecting part behind through which a screw B passes and fixes the screen frame S of the camera. The latter is simply composed of the screen-frame with bellows (which should be longer than usual) and a thin frame in front pierced for the reception of the sliding tube of the microscope. To this last frame a small length of brass tube R is fixed together with a screw, the microscope tube passing through and being fixed by the screw after final focus has been obtained. The eye-piece of the microscope is passed from behind into the sliding tube when the bellows are slack.

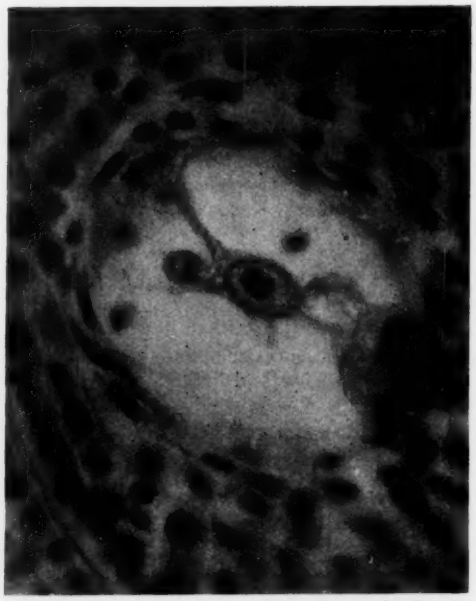


Fig. 3.—Embryo-sac of Helleborus, showing the completed maturation stage.

The front block A serves as a stand for the microscope, and has three small wedges screwed on the top which serve to fix the feet of the microscope-stand. From the lower edge of the front frame of the camera is fixed a rod with a screw below. This rod is moveable along the base-board in a slot, and can be fixed at any point with the screw. By this means great steadiness may be ensured.

The lamp L can either be on the same base-board or on a separate block. Perhaps the better plan is to have it on the same base-board. A condenser can be arranged between the lamp and the microscope; as for illuminating agent, I have found a broad paraffin flame to give as steady a light as possible, but, of course, exposures are necessarily somewhat longer than with the electric lamp or the acetylene flame.

For a focussing surface at the back of the camera I have found a fine ground-glass screen with a little olive oil rubbed into the ground surface serve very well, but occasionally for very fine focussing it is necessary to

fix a round cover-slip on to the middle of the ground surface with some Canada balsam, and by means of an eye-lens placed on the back surface of the screen, and of such focal length that an image in the plane of the front surface of the cover-glass is clearly seen, determine when a correct focus has been obtained,* but in most cases careful naked-eye observation of the sharpness of the image on the ground-glass suffices. While coarse-focussing the rod which fixes the front frame of the camera should be left loose, so as not to hinder the sliding movement; in fact, in many cases the rod may be dispensed with, as there should be no extra strain about the apparatus.

The tube of the microscope should slide easily in the tube R. When this is so the rod can then be fixed and

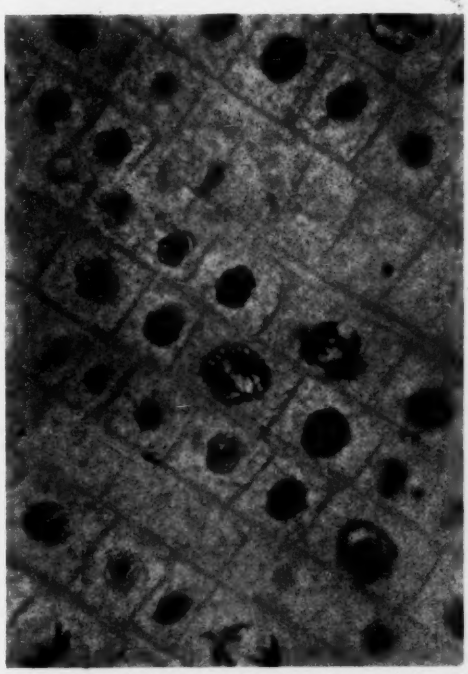


Fig. 4.—A "Spireme" stage (central nucleus) from root-tip of Allium.

the fine adjustment of the microscope used until the final focus is obtained.

With the above apparatus good results can be secured with care. The photographic plates which give the best results are the Ilford Backed Iso-chromatic (rapid), since, with these, halation effects are brought to a minimum and the film is standardised so as to be nearly equally affected by any rays about the middle of the spectrum. Still, for the staining of objects, it is better to use a stain which has a known actinic effect on an ordinary Ilford plate, as the result is usually better.

With regard to a focussing screen, I have tried an unexposed photographic plate which has been cleared in hypo., and then, whilst still in the hypo. solution, treated with a few drops of hydrochloric acid. This precipitates sulphur in the form of a fine homogeneous deposit in the film and gives an opaque milky surface upon which good focussing can be carried out. This method, of course, gives us a focussing surface analogous to the final surface upon which the photograph is taken, and would seem to give good results, but many trials are necessary before the requisite deposit of sulphur is formed in the film, for if the deposit is too small, the film is too transparent to focus upon.

To recapitulate: (*a*) See that *rigidity* is ensured throughout all the parts of the apparatus. (*b*) See that the tube of the microscope slides easily in the tube R on the front frame of the camera. (*c*) Use a micro-

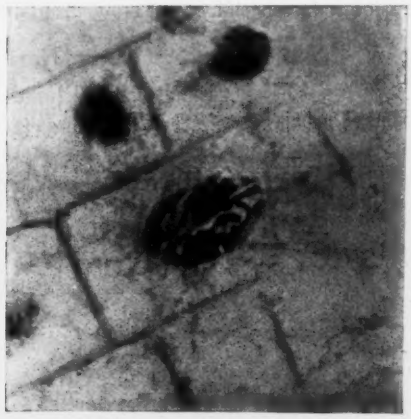


Fig. 5.—A "Spireme" stage from root-tip of Allium.

scope of simple construction (the mirror under the stage being, of course, dispensed with), and which has good objectives; the eye-piece may be also dispensed with, but, as a rule, it is as well to use one, since a fair magnification with a short length of bellows is thus obtained. (*d*) See that the feet of the microscope-stand

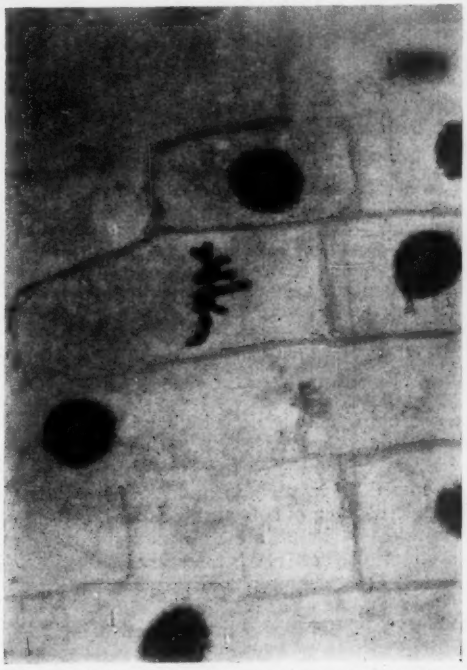


Fig. 6.—The "Monaster" stage from root-tip of Allium.

are fixed firmly by the wedges on the top of the block; also have the lamp firmly fixed by some similar method on the top of its block.

By attending to these points good results will, I think, be ensured. From a practical point of view I have found that with a steady flame from a good

* A thin screen of transparent glass is sometimes used and the focussing done with an eye-lens; this gives excellent results.

paraffin lamp about six inches from the stage of the microscope, and by carefully using the sub-stage diaphragm for stopping down the peripheral rays, an exposure of about 5 minutes when the ½-inch objective is used, and about 15 to 20 minutes when the ⅛-inch is used, an ocular being also employed, has sufficed with the isochromatic plates. Sometimes, however, more time is required, especially if the object to be photographed is rather thick. When oil-immersion objectives are used a very long exposure is required, but for most purposes the ⅛-inch used with an ocular and the bellows drawn out to about 18 ins. will give good magnification. It must be remembered that the smaller the aperture of the objective and the higher the power the less the illumination in the screen, and the more difficult it becomes to obtain good definition, although, of course, what is known as the "resolving power" becomes greater.* With these few remarks we will pass on to the actual results which may be obtained in the photography of nuclear division, from longitudinal sections of root-tips of Hyacinthus, Allium, and Nymphæa, as well as longitudinal sections of the young axis of the female cone of Larix, the embryo-sac of Caltha palustris and Helleborus niger in the endosperm-forming stage, and the young embryo-sac of Lilium martagon, all of which furnish very good material to work with, as all stages in the process of mitosis can be made out from these. The material before sectioning was first fixed in chrom-osmium-acetic acid (Flemming's solution), washed, and hardened in spirit.

Fig. 7.—A high-power (1/10' "oil-immersion") photomicrograph of the stage where the Monaster has split. The nuclear spindle is well defined. (Hyacinthus root-tip.)

The sectioning may be done by hand with a razor (not hollow-ground), the root-tip or other structure being embedded in split pith, or the material to be sectioned may be embedded in paraffin and sections taken with a special microtome; but I am inclined to think that sections taken by hand, although not so thin as microtome sections, are better, for the reason that the delicate cells of root-tip, etc., are not distorted so much, and the protoplasm and nucleus retain their relative position much better. After some little practice it is easy to cut sections in pith which will be less than a cell thick. The photomicrographs accompanying this paper were all taken from sections cut by hand. Paraffin embedding in the case of vegetable tissues is a lengthy process, on account of the cellulose walls, which even after long treatment with xylol and xylol-paraffin in various proportions are not easily penetrated by the paraffin. Another advantage of the hand method is the fact that the subsequent processes of staining and dehydrating are rendered easier and more certain in their effect. I have, of course, nothing to say against paraffin embedding and microtome sections in the case of animal tissues and certain vegetable tissues (very small objects, such as pollen-grains and such like).

The fixation in Flemming's solution of the material to be used for investigation is a most important point, as the nuclei and cytoplasm are at once fixed, and karyokinesis in all its stages may be studied with the certainty that the nuclear elements and the cytoplasm have retained their relative position to one another without any, or, at least, with very slight, shrinking.

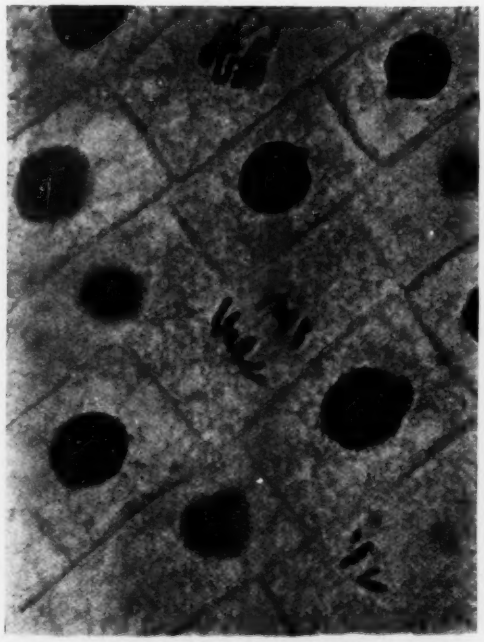


Fig. 8.—The daughter-loops are shown travelling away from one another. (Allium root-tip.)

Naturally the result obtained by photography will depend upon good selection of our mitotic figure, and a good deal of patience is required in this selection. The staining of the figures is also, as before-mentioned, a very important factor, and I have found that a triple stain of orange-G, safranin, and gentian-violet * (the stains being used separately and rather dilute, and the sections washed in distilled water after each stain), to be one of high actinic power. Bismarck brown is also a good stain, and the Ehrlich-Biondi triple stain gives at times beautiful results. But I do not think methyl-green alone is a very good stain for photographic purposes. Safranin, however, when used alone, gives good results, with the exception that the nuclear spindle does not show up very well. These brief remarks on the preparation of sections will serve to remind the reader that not only must our apparatus be efficient, but our preparations must have been made according to some well-tested method.

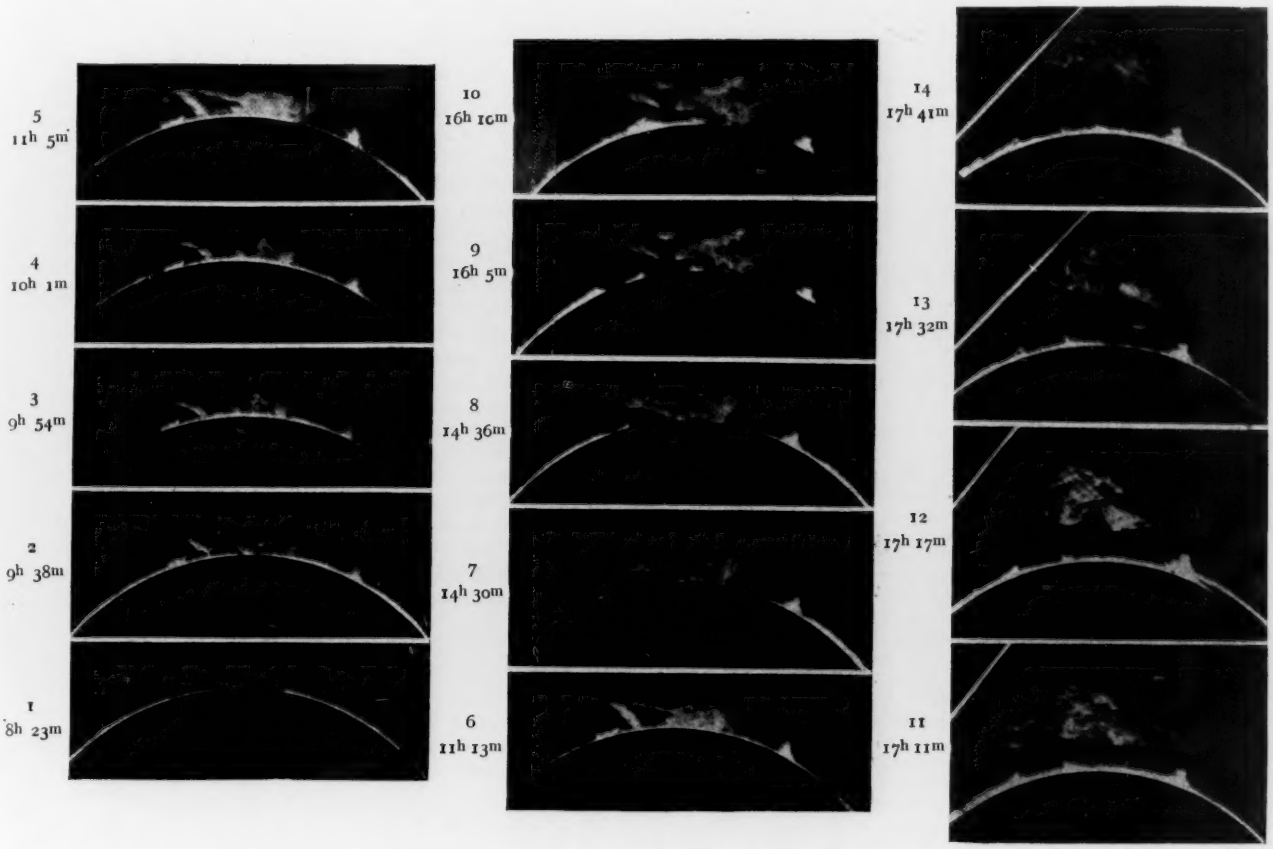
The photo-micrographs which I have chosen in the present paper for the purpose of illustrating the results which may be obtained were, of course, not secured without some preliminary trials.

* I have purposely omitted to mention the use of the "projection ocular," as this is only required for very advanced work.

* 5 % solutions in distilled water.

A Large Solar Prominence.

BY what the author describes as a fortunate chance, but which appears more probably to be the reward of very close and painstaking attention, Mr. J. Evershed has been able to secure a good series of negatives showing the development and final rapid ascent of a very large prominence, using the spectroheliograph at the Solar Physics Observatory, Kodaikanal, South India.



Prominence of February 18, 1908 (Indian Standard Time).

It is part of the usual routine of the work with the spectroheliograph to secure two good plates of the prominences all round the limb, generally in the morning between 8 and 9 a.m., when the definition is best. On February 18, 1908, a third plate was exposed, which showed that there had been a remarkable development during the previous half-hour of a prominence only shown faintly on the first two plates, extending from position angle 89°-127°.

The appearance was of a type which has seldom been recorded, and arrangements were therefore made to continue taking records of that section of the limb throughout the day. Visual observations had indicated a moderately bright mass of prominences, extending from 89°-121°, with bright condensations at 91° and 97°; the sodium and magnesium lines were seen bright at 91°. In all, 20 photographs were secured, fourteen of which are reproduced in Mr. Evershed's paper, showing the development of the prominence from 8h. 23m. up to 17h. 41m.

Notwithstanding the sudden appearance of such a large prominence mass, the subsequent increase took place very gradually. The visual observations in the $H\alpha$ line showed scarcely any evidence of radial velocity in the line of sight. The actual variations in height are shown in the following table, which gives the approximate rate of ascent in the mean interval between successive pairs of photographs.

Indian Standard time 5h. 30m. ahead of Greenwich.	Mean height in Seconds of Arc.	Approximate Velocity of Ascent, Km. per sec.	Indian Standard time 5h 30m. ahead of Greenwich.	Mean height in Seconds of Arc.	Approximate Velocity of Ascent, Km. per sec.
H. M.			H. M.		
8 23	..		16 5	202″	
9 38	81″		16 10		
		12			24
9 54	100		17 11	337	
10 1			17 17		
		1·2			37
11 5	107		17 32	405	
11 13			17 41		
		2·5			84
14 30	150		17 56	Too faint to measure.	
14 36					
		6·7	18 2	585	

The most striking feature is the accelerating velocity with which the entire mass leaves the sun, as is clearly

shown in the last few photographs of the series. The prominence appears to diminish in brightness as it ascends, but this may be due to the fact that these last exposures were taken with the sun nearly setting, the altitude at 17h. 41m. being only 8°, while at 18h. 2m. it was less than 3°. Another conspicuous feature is the long filament joined to the main mass and arching over the small bright prominence. Only two previous examples of similar prominence action to this of February 18 are known, one being observed by Mr. Evershed himself at Kenley on October 3, 1892; the other was photographed at Kodaikanal on April 9, 1907; this showed a mass of interlaced filaments, and was subject to an accelerated velocity of ascent during its development.

It is specially remarkable that the disc photographs taken in K light obtained on the dates April 9, 1907, and February 18, 1908, show no flocculi nor any kind of disturbance near the positions of the prominences.—(*Astrophysical Journal*, Vol. 28, p. 79, July, 1908.)

C. P. B.

Electrical Flow.

SOME of the investigations which Professor F. E. Nipher has been making to determine the direction of flow of an electric current in a wire have been reported by him to the American Philosophical Society, and will form the basis of an extremely valuable theory. Professor Nipher suggests that when an electric current is sent through a wire the phenomena which result may be likened to those of a fluid in a pipe with porous walls. Let us suppose, for the sake of illustration, that the pipe has a bend or sharp angle in it. A piston at one end of the pipe may be forced sharply inward. A *compression* wave will travel along the pipe. The fluid might leak through the walls, and particularly might it do so at the leeward side of an angle in the pipe. A parallel tube with a piston, which should be given a sharp pull, would send, or induce, a *rarefaction* wave along the pipe. Now suppose the two parallel pipes joined at their open ends. The two waves, one of compression the other of rarefaction, would be going in opposite directions in the pipe, *but the flow or current would be in the direction of the compression wave.* The negative discharge he finds to be similar to this compression wave. The electrons or negative particles travel from the negative terminal of the machine giving the electric charge and they constitute the current of electricity. Professor Nipher arrived at these conclusions by the installation of devices which enabled him to send either a positive or negative charge through a wire. Another device enabled him to lead the charge round a sharply made angle in the wire. Photographic plates were arranged below the angle for purposes of investigation. He found that when the negative discharge plunged down to the angle the electrons passed on into the air and through the rubber covering of the wire on to the photographic plate, which registered them. When the positive discharge was sent around the angle no such effect was produced. The negative discharge was in the direction of the real flow of electric corpuscles, and these corpuscles have momentum.

ELECTRO-MEDICAL APPARATUS.—We have received from the Sanitas Electrical Co., Ltd., of 61, New Cavendish Street, W., a copy of their New Catalogue of Electro-Medical Apparatus. It is by far the most elaborate list of the kind we have so far seen, running to some 340 pages of descriptive matter and illustrations, including all the most novel and recent appliances devised for the application of X-rays, and other forms of electricity, to medical and surgical science The Catalogue is most conveniently arranged in sections, allowing of easy reference, and should be in the hands of all those interested in any branch of the subject.

Ions.

By R. G. DURRANT.

PART I.

IONS may be defined as "things which move." The name, like that of atoms ("things which cannot be cut up") is derived from a Greek verb.

The word was coined by Faraday, who used it to express those things which move with or against the electric current when that current passes either through solutions of salts or through melted salts. Thus, if common salt is melted and a current is made to pass through, the metal sodium makes its appearance where the current leaves, while the yellow gas chlorine makes its appearance where the current enters the melted salt.

There is no appearance of the metal nor of the gas except at the two poles which conveniently may be made of gas-carbon. It is found that as more and more sodium and chlorine are produced less and less salt remains. The question arises as to how the sodium and chlorine travel toward their respective poles. They do so in opposite directions but evidently not in those forms which we recognise at the poles, because the very remarkable properties of sodium and of chlorine are not manifested in the intervening space. Faraday saw clearly that *something* must move with the current, and this becomes sodium at the end of the journey. He called it the sodium ion and since, like other metallic ions, it moves *with* the current, it was called a kat-ion, while chlorine ions, which, like other non-metallic ions, move *against* the current, were called "an-ions."

Faraday showed that definite charges of electricity are carried by the various ions—those of sodium, silver, and hydrogen all carry the same charge, which is called positive, while ions of chlorine, bromine, and iodine all carry charges exactly similar in amount, but of the opposite kind. Copper ions also may carry the same positive charge as is carried by sodium or silver, but other copper ions can carry exactly double that charge; the former are called cuprous, and the latter cupric ions.

In the case of iron, we have ferrous and ferric ions which respectively carry two and three positive charges. The terms "positive" and "negative" are arbitrary, and are derived from earlier conceptions. More recent work has shown the real flow to be a reversal of the conventional direction. Although there are chemists who do not accept the theory or who minimise the importance of ions, I shall assume their existence and shall attempt to explain some at least of their operations.

To begin with, I must shortly describe the theory of Grotthus, which for many years was regarded as sufficient to explain such a case as that of passing a current of electricity through melted salt. Salt was known to be "made up" of sodium and chlorine, joined in some way which masks the individual properties of these two elements as they appear in the free state. Grotthus would suggest that each molecule of salt—which, when simply melted revolves and moves about aimlessly—is suddenly made to "stand at attention" if a current

of electricity is started. Each molecule takes up a position so that the chlorine end of it points up the electrical stream while the sodium end points down stream. The first and nearest atom of chlorine is now torn off at the pole where the electricity is supposed to enter, that is, at the *anode*, while at the same instant the last atom of sodium is torn off at the other pole—at the *kathode*.

This tearing off of ultimate atoms causes an instantaneous change of partners all along the line and suggests that each new couple revolves through half a circle so as to be ready for the next appropriate atoms to be torn off at their respective poles. In this way the facts—that sodium and chlorine appear at the poles and do not appear in the space between—were explained.

The theory of Grotthus was put forward in 1805. It was extended by Clausius to make it meet more modern views and to explain such further facts as the following—namely, that a feeble current will often start electrolysis, that is, separation brought about by electricity—but that after a short time further separation will cease and the current will stop. Clausius supposed that when salt is melted or is dissolved in water its molecules are partly broken up into atoms and that both molecules and atoms glide about promiscuously; at any given moment some molecules are splitting up while others are being re-constituted from those atoms of chlorine and sodium which happen to meet one another. As soon as the current is started all the free atoms of sodium start off in the direction of the kathode and all the free atoms of chlorine start off in the other direction. If the "electro-motive" force from the battery is great enough, then casual re-unions are relentlessly stopped. There is to be no parleying on the way, ions of chlorine and of sodium must pass each other, perhaps with reluctance, and emerge as elements at either pole.

If, however, the electro motive force is feeble it will start the same movements, but when a sufficient number of chlorine and sodium ions have been dragged or urged *vis à vis*, then the combined tendency toward temporary re-union is sufficiently great to offer, as it were, an organised resistance, and so electrolysis is prevented.

Clausius's views are a distinct advance on Grotthus's. There can be no doubt but that this tendency toward re-union between elements such as sodium and chlorine is itself of an electrical nature. This is shown in our storage batteries. In these, the separation is brought about by a powerful current from a dynamo, the products of this electrolysis are stored at the poles of the cells through which the current passes. Then the dynamo is disconnected, and when required the battery poles are connected through lamps or otherwise. The separated products now move steadily back toward each other, join again, and in so doing circulate a reverse current which is utilised.

Before proceeding to further extensions of Clausius's theory, it may be noticed that comparatively feeble currents are sometimes useful, and especially so in the art of electro-plating.

About 1840, Messrs. Elkington introduced their commercial process. In this process the liquid between the poles consists of silver cyanide dissolved in potassium cyanide. The anode pole is a solid ingot of silver, while the kathode pole is the object to be plated—say, a copper spoon. The theory of this process has been studied by Hittorf, who explains, in the following way, why the double cyanide of silver and potassium yields an even deposit of silver whereas ordinary silver nitrate solution yields no even deposit but branching crystals of silver. He maintains that the ion which moves to the kathode is not silver but potassium, and that the silver joins company with the cyanide to form a complex an-ion, and consequently moves up to the silver ingot which constitutes the anode; what then happens is as follows:—The potassium ion as soon as it reaches the copper-spoon (the kathode) becomes converted into the metal potassium and this instantly turns out some metallic silver from the solution close at hand. This metallic silver quickly settles on the copper, while the potassium is converted into potassium cyanide once more. Meanwhile, at the other end the complexion ($Ag\ Cy_2$) attacks the silver ingot causing it to "drop" an atom of silver into the solution and this reproduces the original double cyanide. If this process is intelligible to my reader he will perceive that silver in solution should be scarce when it is wanted, and should accumulate near the ingot, where it is not wanted, whereas if silver simply moved across from the ingot to the spoon such local scarcity and superabundance would not occur. Experiment shows that there *is* a tendency to get scarcity of silver near the spoon but this tendency is corrected by another—the natural tendency of separated liquids to become evenly mixed by inter-diffusion; any local deficit may be completely obviated by judicious stirring.

Hittorf's name has been mentioned, and I must refer to it once more in connection with some important work which has extended our knowledge of ions under the guiding influence of the electric current. This work was done from 1853 to 1859, but was not duly recognised until quite recently. Without going into details, the principle upon which Hittorf worked was to pass currents through salt solutions, to remove sections of the liquid after certain intervals of time and then to analyse these portions. He found that the concentrations varied in different sections, and from this he proved that the rate at which various ions move is different. He showed, for instance, that when a solution of copper sulphate is electrolysed, the copper ion will move over three spaces, while the sulphate ion (SO_4) only moves over two spaces and in the opposite direction. The relative rates of motion of many different ions he expressed by numbers, and these are known, in England, as Hittorf's *transport numbers*.

Sir Oliver Lodge, in 1885, was the first to give what may be called an optical demonstration to show that ions move at different rates. The demonstration was as follows:—A fairly narrow tube is filled with a jelly made of water, gelatine, common salt, and a little alkaline phenol-phthalein. This last ingredient gives the whole jelly a fine red colour. One end of the jelly tube dips into hydrochloric acid, and the other end into some other chloride. The jelly tube is itself part of the "cell" and the current (conventional direction) is passed through from the hydrochloric acid end. What happens is this: The hydrogen ions (called hydrions) like those of metals, move down current while the chlorine ions (called chlorions) move in the opposite direction. The effect of each kind of ion is to remove the red colour from the jelly. The hydrions remove it because they are acidic in their action, and neutralise the alkali originally employed to make the phenol-

XUM

phthalein turn red. The chlorions also remove the colour, starting from the other end, because when they react they have a bleaching action on this as also on many other colours. In this way the bleaching process is watched from either end of the tube until the whole is colourless. The stream of hydrions is observed to move about six times as fast as the stream of chlorions. The actual rates are slow and depend on the "potential gradient" of the current through the jelly tube.

Many methods have been devised since this by means of which the drift of various ions may be made visible and their relative "mobilities" deduced. Foremost among workers in this field are Whetham, Orme, Masson, and B. D. Steele.

Hitherto I have only touched on what may be called incidental peculiarities of ions. I must now state that in the opinion of the School of Physical Chemists *nearly all chemical reactions are brought about by the agency of ions.* This is a strong statement, and if true it is evidently of the utmost importance, for besides "laboratory" reactions, there are the life processes in plants and in animals, and in these also ions are active. Not only do we believe ions to be the active agents in bringing about reactions, where they themselves are changed, but also in bringing about reactions where other things are changed, ions, as defined above, are "things which move," and when they move they hustle everything near them. I should like to convince my readers that these statements are not exaggerated, and if possible to do so in a practical way.

There is an apocryphal legend to the effect that Hannibal penetrated certain mountains, presumably of limestone, by dissolving them in vinegar. I will ask anyone so disposed to procure a lump of limestone or of marble and also to buy some very concentrated vinegar sold under the name of glacial acetic acid, and further, I will ask him to place some of the limestone or marble in this acid; he will perhaps be disappointed since nothing visible will happen, but if now a considerable quantity of water is added, bubbles of gas will rise and the lump will gradually disappear. The chemist who sells glacial acetic acid will probably sell also blue litmus paper, used so often as a test for acids, which turn it red. If this blue paper is well dried in front of a fire and then thrust into the glacial acid, again nothing will happen except that the paper looks wet, but if it is removed and thrust into a tumbler of water it will rapidly turn bright red.

One more experiment. Purchase a little magnesium ribbon and dip it into this acid. Nothing will happen; but add water, and hydrogen gas will bubble up while the magnesium will soon disappear.

Perhaps these simple experiments will suggest no further inference beyond the obvious one that very concentrated vinegar can neither dissolve limestone nor magnesium ribbon, nor can turn litmus red, while "weak" vinegar can do all these things. It should therefore be said at once that several quite independent researches have shown concentrated vinegar to be practically un-ionised, but they also have shown that when water is added hydrions are set free together with a complex an-ion ($C_2 H_3 O_2$). As long as there were no free ions the vinegar failed to react in the above experiments; as soon as ions were set free the changes took place. I should like to illustrate a case where ions "hustle up" a change which is not itself dependent on the ions.

The soluble chloride of mercury (corrosive sublimate) is only very slightly "ionised" when dissolved in water; if a bright shaving of copper is placed in the solution a very slow deposit of quicksilver occurs, due to the very occasional ions of chlorine reacting with the copper, and to the very occasional ions of mercury discharging on the surface of the remaining copper. If some fairly concentrated hydrochloric acid is added to the solution of mercuric chloride and a copper shaving is dropped in, it will be seen that the shaving almost instantly becomes coated. This is because hydrochloric acid, even in a concentrated state, is highly "ionised," its ions, especially the hydrions, hustle the mercury ions so much that the change is brought about very quickly. In a similar way this highly ionised hydrochloric acid will hasten up many otherwise sluggish chemical changes. It is easy also to show how much more rapidly it will act on marble or on magnesium than is the case with diluted acetic acid.

Since the discovery of electrons, chemists have endeavoured to show how these "atoms of electricity" are connected with ions which move about in solutions. I propose to revert to the case of common salt dissolved in water and to consider this question with reference to the ions present in salt water. In this case we have at least six things to consider. (1) The salt itself, which is sodium chloride; (2) the sodium ions separated from the salt; (3) the chlorine ions also separated from the salt; (4) the water itself, which is oxide of hydrogen; (5) the hydrogen ions (hydrions), separated from the water; and (6) the other ion separted from the water. This last is not oxygen, but oxygen joined to half the hydrogen; the ion is called "hydroxyl" or "hydroxidion." This salt water at any given moment contains a certain amount of sodium chloride symbolised by the "formula" NaCl. If the water is not very salt there is probably a larger amount of sodium and of chlorine ions symbolised $Na^{\cdot}$ and Cl' respectively. The symbol $Na^{\cdot}$ means an atom of sodium *lacking one electron*, and the symbol Cl' means an atom of chlorine *carrying one extra electron.*

There is a very large amount of water usually symbolised as H_2O, a symbol which implies two atoms of hydrogen joined to one of oxygen. This symbol truly represents the composition of steam, but there is strong evidence to show that water, as a liquid, is in a condensed molecular state; part of it may be $H_4 O_2$, part $H_6 O_3$, and possibly the molecules may "associate" to a still greater extent. But some of the water is ionised, though to a small extent; the hydrions are symbolised as $H^{\cdot}$, or atoms lacking one electron, and there are an equal number of hydroxidions symbolised as $(O H)'$ and carrying one extra electron. Further, it is probable that the very fact of "sodions" and "chlorions" being free, causes a larger number of hydrions and hydroxidions to be set free than would be the case in pure water.

Symbols and formulæ such as those just given are valuable to those who are constantly using them, but there is a danger, even with "experts," that the symbol should become an abstraction, that while it serves to elucidate results it may fail to keep in view the moving things themselves which bring about those results.

(To be continued.)

The Spectra of Comets, and the "Swan" Spectrum.

By W. MARSHALL WATTS, D.Sc.

ONE of the most interesting applications of spectrum analysis in astronomy is to the determination of the nature of comets. Many hundreds of these mysterious bodies have been observed, some periodic, returning time after time; others are seen once and never seen again. Many readers of this article may remember the magnificent comet which appeared in 1858—Donati's—exhibiting a "tail," which extended 40° across the sky. It is unlikely that we shall have any reader who can recollect the last appearance of Halley's comet in 1833, the return of which may be looked for in 1910.

Sir William Huggins was the first to identify the comet-spectrum with that of carbon. He thus describes his observation of the comet of 1868:—

"I had myself, in the case of three faint comets in 1866, 1867, and in January, 1868, discovered that part of their light was peculiar to them, and that the light of the last one consisted mainly of three bright flutings. Intense, therefore, was the expectancy with which I directed the telescope, with its attached spectroscope, to the much brighter comet which appeared in June, 1868.

"The comet's light was resolved into a spectrum of three bright bands or flutings, each alike falling off in brightness on the more refrangible side. On the evening of the 22nd, I measured the positions in the spectrum of the brighter beginnings of the flutings on the red side. I was not a little surprised the next morning to find that the three cometary flutings agreed in position with three similar flutings in the brightest part of the spectrum of carbon. Some time before, I had mapped down the spectrum of carbon from different sources, chiefly from different hydrocarbons. In some of these spectra the separate lines, of which the flutings are built up, are individually more distinct than in others. The comet bands, as I had seen them on the previous evening, appeared to be identical in character in this respect, as well as in position in the spectrum, with the flutings as they appeared when I took the spark in a current of olefiant gas. I immediately filled a small holder with this gas, arranged an apparatus in such a manner that the gas could be attached to the end of the telescope, and its spectrum, when a spark was taken in it, seen side by side with that of the comet.

"Fortunately, the evening was fine; and on account of the exceptional interest of confronting for the first time the spectrum of an earthly gas with that of a comet's light, I invited Dr. Miller to come and make the crucial observation with me. The expectation which I had formed from my measures was fully confirmed. The comet's spectrum, when seen together with that from the gas, agreed in all respects precisely with it. The comet, though 'subtle as Sphinx,' had at last yielded up its secret. The principal part of its light was emitted by luminous vapour of carbon."

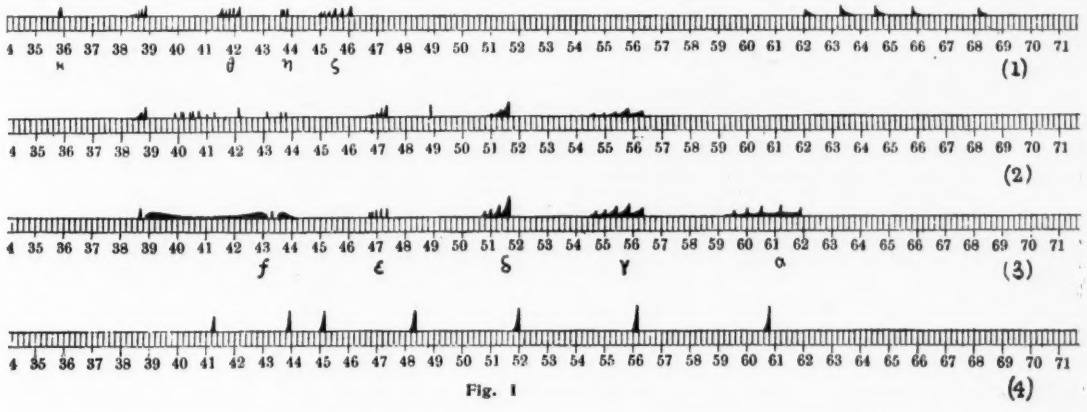


Fig. I

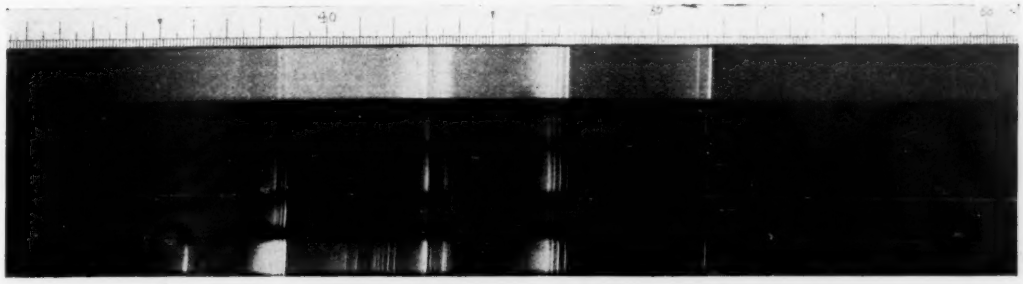


Fig. II.

The reference spectrum employed by Sir W. Huggins, that of the spark in olefiant gas at atmospheric pressure, agrees exactly with the "Swan" spectrum seen from the bright green cone at the base of a Bunsen flame, and obtained still more brightly by burning olefiant gas and oxygen together in a "mixed" jet. This spectrum was first described by Swan in 1857, and was considered by him to be due to a hydrocarbon. A fine coloured representation of this spectrum is given by Plücker and Hittorf in the Philosophical Transactions for 1865. It is mapped according to wave-lengths in Fig. I. (3).

Attfield, observing that the same spectrum could be obtained from compounds of carbon with nitrogen, oxygen, and sulphur, concluded that the spectrum must be that of carbon itself. Morren, who particularly describes the brilliant spectrum produced by burning cyanogen with oxygen, arrived at the same conclusion.

This flame gives the groups of bands: α (in the red), γ (greenish-yellow), δ (emerald-green), and ϵ (blue), brilliantly, but shows also at the blue end of the spectrum the groups ζ, η, θ, ι and κ mapped in Fig. I (1). These groups are generally attributed to a compound of carbon and nitrogen. They are seen in the carbon-arc in air or nitrogen, but are not present in the flame of hydrocarbons, as may be seen in Fig. II., where the upper photograph is the spectrum of the Bunsen flame, and the bottom photograph that of the spark in alcohol, containing a trace of ammonia. The spark in alcohol without ammonia shows the groups γ, δ, ϵ and f, but no trace of the cyanogen groups ζ, η, θ, ι and κ, which make their appearance when the slightest trace of ammonia is added. Fig. II (2) shows the spectrum of the spark in alcohol without ammonia, and Fig. II. (3), II. (4), and II. (5), the spectra obtained after the addition of one drop, two drops, and five drops of an alcoholic solution of ammonia to the alcohol used for II. (2). The series of photographs shows the gradual development of the cyanogen groups.

In 1881, Sir W. Huggins obtained the first photograph of the spectrum of a comet. It showed the combined spectra of two kinds of light, a faint continuous spectrum crossed by Fraunhofer lines, which showed it to be reflected solar light. Upon this was seen a second spectrum of the original light emitted by the comet itself, and this showed a band belonging to a nitrogen compound of carbon. We thus gained the new knowledge that nitrogen as well as carbon exists in comets. In Fig. I. (2), is shown the spectrum of Comet 1899*a* (Swift's Comet), in which the cyanogen group at 3883 (Cy ι) appears as a very bright band, besides the groups ϵ, η and θ.

The comet-spectrum is too faint to enable us to observe the detail in structure of these bands due to carbon and cyanogen, but they are seen in great beauty in the photographed spectra of the arc between carbon poles in air, under suitable electrical conditions. I am indebted to my friend Mr. E. E. Brooks, of Leicester, for the beautiful photographs of the cyanogen groups Cyθ, and Cyι, as produced in the calcium flame-arc. Fig. III. shows the group Cyθ, the "edges" of which have the wave-lengths 4216.1, 4197.2, 4181.0, 4167.8, 4158.2, and 4152.9.

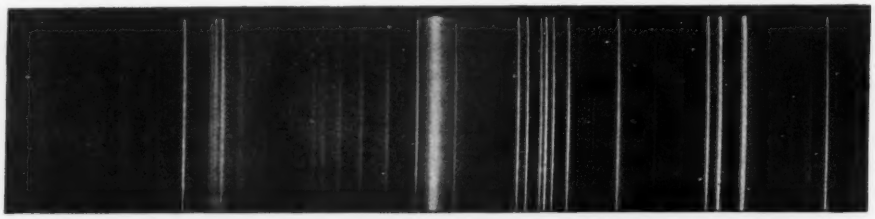


Fig. III.

Fig. IV. is a reversed print from the negative, and shows the group Cyι with edges at 3883.6, 3871.5, 3861.9, and 3855.1, as well as the calcium lines H and K, whose wave-lengths are 3968.6 and 3933.8. In this reversed photograph the cyanogen group may be compared with the same group in the solar spectrum, as seen in Fig. V., which is reproduced by permission, from Mr. Higg's splendid photograph. It is of much interest to find this cyanogen group, not only in comets but also in the sun, and in the red stars of Secchi's fourth type, commonly called "carbon" stars. Of these, over two hundred are known. Their spectra show three dark bands sharp towards the red, and degraded towards the violet, presenting a negative copy of the emission bands of comets, together with certain lines of iron and sodium, but no lines of calcium, hydro-

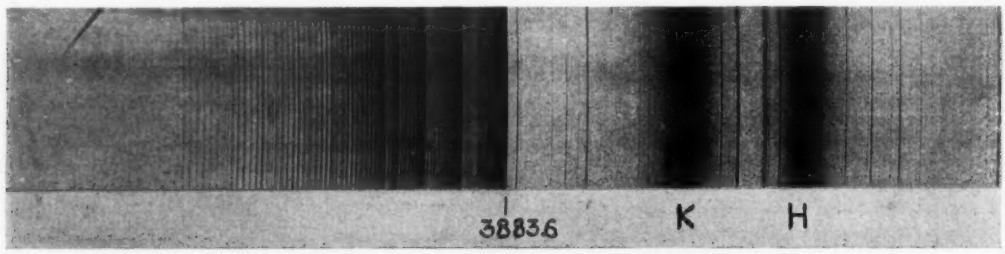


Fig. IV.

gen, or helium. The brightest of these stars is 152 Schjellerup, in Canes Venatici.

It has been shown that there is a close connection between the orbits of certain comets and those of periodic meteor swarms. The gases occluded in meteorites which have fallen upon the earth have been found to be hydrogen, carbon-monoxide, and carbon-dioxide, hydrocarbons and nitrogen. There is little doubt that the original light emitted by comets is produced by electrical discharge. Arrhenius has pointed out the possibility of a discharge of negatively electrified particles from the sun, which would form nuclei of condensation.

Sir W. Huggins obtained his comparison-spectrum by taking the spark in olefiant gas (or in olive oil), at atmospheric pressure, and the same spectrum is given by the direct discharge, without jar, in carbon-monoxide, carbon-dioxide, cyanogen, hydrocarbons, &c., and also when the spark is taken in liquids not containing oxygen, such as heptane, benzene, chloro-

Dr. Copeland observed the bright sodium line, visible not only in the nucleus, but also in the surrounding coma, so that with a wide slit the outline of the head was seen in yellow light. The great September comet of 1882 showed the same peculiarity. Besides the carbon bands, the sodium line, and six lines identified as belonging to iron, were seen: the sodium line became weaker, and the carbon bands stronger, as the comet receded from perihelion.

The changes, often very rapid, which may take place in a comet as it approaches the sun, resulting in the development of a tail or tails apparently formed of matter driven off from the head, indicate a repulsive force emanating from the sun. Donati's comet, besides the main tail 40° long, developed two smaller, nearly straight tails.

According to the theory of Arrhenius, this repulsive force is accounted for by the pressure of light. Maxwell, in 1873, pointed out that sunlight on the earth's surface should exert a pressure of 0.592×10^{-10}

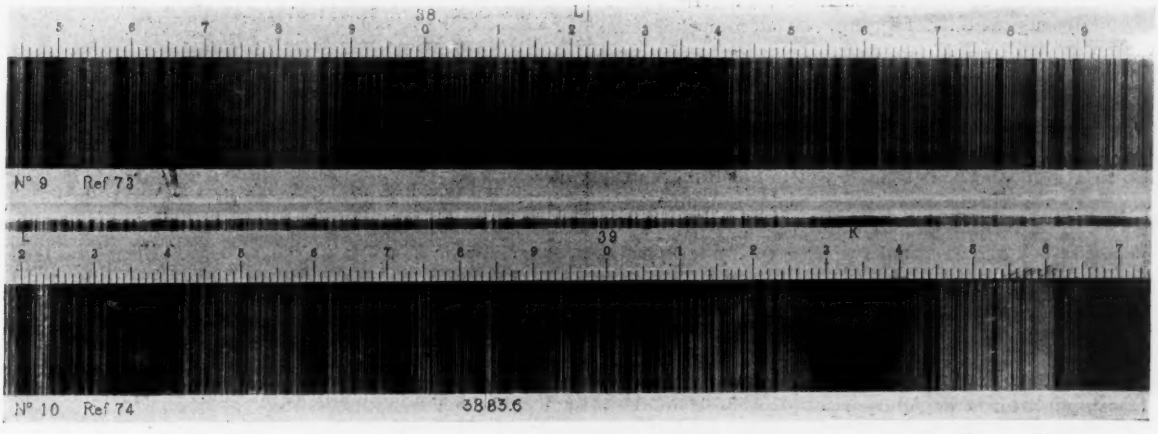


Fig. V.

form, carbon tetrachloride, aniline, ethylene, dibromide, ethyl bromide. But in carbon monoxide or dioxide, at a sufficiently low pressure, as in a vacuum-tube, we obtain an altogether different spectrum—that mapped in Fig. I. (4). This is the ubiquitous spectrum, seen in nearly every vacuum-tube which has been filled without sufficient precautions to exclude traces of carbon compounds (from dust or lubricating grease).

There is no doubt that this spectrum is that of an *oxide* of carbon. It consists of six bands, with edges at 6079.0, 5610.3, 5198.3, 4835.4, 5411.0, and 4393.2. A vacuum-tube filled with purified benzene and containing pieces of bright metallic sodium, showed this spectrum at first, but on heating the sodium, the spectrum disappeared, giving place to the Swan spectrum. On introducing a little oxygen into the tube, by heating a fragment of potassium chlorate, wrapped up in platinum foil which had been previously put into the tube, this spectrum of carbon *oxide* at once came out again.

If a vacuum-tube containing a hydrocarbon at a pressure of about one-third of an atmosphere and metallic sodium be heated, the sodium line becomes bright, and the Swan spectrum becomes enfeebled. Apparently, the discharge is carried by the sodium—in preference to the gas—as the tube becomes hot.

As a comet approaches the sun, its spectrum may undergo a similar change. In comet Wells (1882 I.),

grams on one square centimetre. At the surface of the sun, a cubic centimetre of water, which on the earth's surface weighs one gram, would weigh 27.47 grams; and the pressure of sunlight on a square centimetre would be 2.75 milligrams. Such a mass would be attracted to the sun, but the case is quite different with bodies of extreme minuteness. A cube of water, whose edge measures one-thousandth of a millimetre (one micron, or μ) would experience an attraction of 27.47×10^{-12} grams, and the pressure of light on its side would be $2.75 \times 10^{-3} \times 10^{-8} = 27.5 \times 10^{-12}$ or rather more than its weight. If, then, the cube has smaller dimensions than this, it will be repelled.

Answers to Correspondents.

B. B. Bateman (*Penrith*).—There is no book or books conforming to the capacity of a pocket containing coloured figures of our flowers and grasses.

Bentham's "Handbook of the British Flora," 2 Vols., one text and the other containing very good figures of every plant (not coloured), is an excellent work. (Lovell Reeve, Publisher.) Or we can recommend "Familiar Trees," by Professor Boulger, with coloured plates (Cassell and Co., Publishers).

XUM

Photography: Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

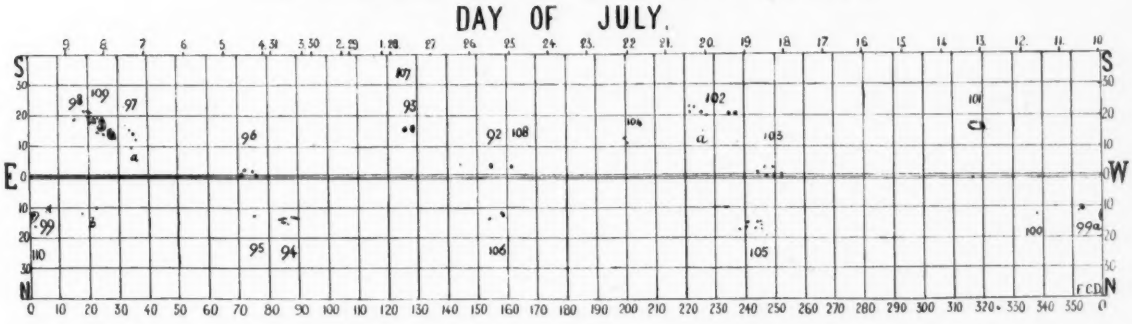
The Infra-Red. Several times during the last year or so, I have referred to investigations on the photographic effects produced by the infra-red radiations, generally with regard to the reversal or undoing by its means of the ordinary action of light in producing the developable condition of the silver salt. M. A. Gargam de Moncetz has just published (*Comptes Rendus*, p. 1022) results that confirm many of these observations, and carry them an important step further. It has already been shown that the developable condition when brought about by Röntgen rays is also reversed by the infra-red, but M. de Moncetz has found that in this case there is a limit to the action, and that beyond (that is less refrangible than) the infra-red that causes reversal, the radiations distinctly augment the fogging, or developable condition, caused by Röntgen rays. In order to eliminate possible accidental fog by more refrangible light, he fixed a cell containing a solution of iodine in bisulphide of carbon immediately in front of the slit, a solution that transmits only radiations in the infra-red, from λ 800 to λ 4,000. The destruction of initial Röntgen ray fog extends from 800 to 920, and the augmentation can be traced from 920 to about 1350. This phenomenon is not shown when the preliminary fogging is done by ordinary light, nor is the unfogged plate sensitive (even with long exposures) to this region of the spectrum.

Ammonium Thiosulphate for Fixing. The use of the ammonium instead of the usual sodium salt for general fixing purposes has often been stated to be advantageous because of its greater solubility, and hence its supposed more rapid action and more ready removal by washing. In order to get the ammonium salt, it is only necessary to add ammonium chloride to the ordinary fixing bath, so that the difficulty of realising these supposed advantages is almost negligible. Messrs. Lumière and Seyewetz have made some comparative experiments on this question and they find that, on the whole, the ammonium salt is not to be preferred. They find that the addition of ammonium chloride to the fixing bath up to about half the amount necessary to change the sodium thiosulphate into the ammonium salt does hasten the fixing considerably, that more than this ammonium salt is useless for the purpose, and that its effect becomes less as the concentration of the sodium salt increases, until with a 40 per cent. solution of sodium thiosulphate the rapidity of fixing is the same whether the ammonium salt is added or not. With the weaker solutions, from 10 to 25 per cent. of sodium thiosulphate, its power of dissolving silver bromide is very markedly increased by the addition of the ammonium salt. But on the other hand, the solutions of the silver salt are distinctly less stable than in the absence of ammonium chloride, and this is so grave a risk to incur, that these investigators consider that it more than counterbalances the slight advantages described.

Photographic Activity of Potassium Salts. The number of substances that are found to be able to change the silver bromide of a photographic plate into the developable condition by being placed near it, presumably therefore, by means of some vapour or some radiant energy that comes from them, is being gradually but greatly extended. Messrs. Max Levin and Rudolf Ruer have found samples from different sources of potassium chloride, sulphate, and carbonate to be active without exception, so that it may be supposed that the potassium is the active ingredient. Sodium sulphate had no action. The effect is slight, being equal to about one-thousandth of the effect of the β-radiation of uranium oxide.

Screen-plate Colour Photography. The method of colour photography by a single plate which contains in itself the necessary three-colour screens and the sensitive layer, the three colours being distributed over the plate in sufficiently small areas to be unobtrusive, if not invisible to the naked eye, is still represented commercially by the Lumière Autochrome plate only. The colour screen is formed of stained starch granules, and in spite of the obvious and practical advantages of the method, it suffers from considerable disadvantages, one of which is the notable loss of light due to the want of transparency of the granules. Varnish or gelatine films can easily be prepared so that they absorb an almost imperceptible amount of light, and as these can easily be stained and their manipulation is in many ways more simple than that of starch granules, there have been several more or less successful attempts to utilise such materials. These attempts indeed began long before the starch-grain method was introduced. The most recent method suggested for suitably distributing the three colours in such a medium, is described in the specification of a French patent granted to Messrs. Lumière. They coat the sheet of glass with gelatine, cover two-thirds of the surface of the film with a fatty ink in lines, circles, or other patterns, and put the plate in a dye solution. The dye is taken up by the gelatine film only where it is not protected by the fatty ink; one-third of its area is thus stained by the first dye. The plate is now coated with a varnish, the solvent of which does not affect the fatty ink, and then by means of a solvent that will attack the ink but not the varnish, the ink is removed and there remains on the gelatine film the varnish-protected parts stained with the first dye. One half the entire surface is now coated with the fatty ink in a suitable design, and the plate is placed in the solution of the second dye. Obviously, this dye cannot be absorbed where the gelatine is covered, either with the fatty ink or the varnish that protects the parts stained with the first dye, but only on that third of the area that is exposed. The plate is varnished as before and the fatty ink dissolved away. The remaining third of the surface of the gelatine film is now colourless and unprotected, and is stained by the third colour by merely placing the plate in the required dye solution. If preferred, the varnish which covers two-thirds of the surface may now be removed, and the triple-stained film coated with a suitable protective medium to prepare it to receive the sensitive emulsion.

Solar Disturbances During July, 1908.



ACTIVITY has been decidedly greater than during June. The longitude of the central meridian was 118°.20′ at noon on July 1.

Nos. 92, 93, and 94 are repeated from last month as they remained visible until July 4, 6, and 6, respectively.

No. 95.—An evanescent pore seen only on July 1.

No. 96.—A group of pores first seen on July 1 in a roughly oval form, pores larger next day, the disturbance being 53,000 miles across, only the eastern and western spotlets remaining 3rd and 4th.

No. 97.—Three pores in line, seen only on 2nd.

No. 97*a*.—Two pores, close north of the last, on 3rd only.

No. 98.—A single small spot, embedded on west side of a faculic mass, which quickly dwindled and died out. 3rd to 6th.

No. 99.—A small spot with two pores *n.f.* on 6th, and one *s.p.* on 7th. 4th to 7th.

No. 99*a*.—A spot 9,000 in diameter, having a minute pore *n.f.* on 7th. A close pair of spotlets on 11th. 5th to 12th.

No. 99*b*.—Pores, minute and changing frequently, group 30,000 miles long. 6th to 9th.

No. 100.—A solitary pore, seen only on 12th.

No. 101.—A pore first seen in afternoon on 14th, next morning a practically complete ring of spotlets had formed 29,000 miles across, the largest *p.* one forming the "jewel." The ring enlarged to 44,000 miles, the leader attaining a diameter of 14,000 miles, and on 16th-17th having its umbra crossed by a bridge. 14th to 18th.

No. 102.—A group of small spots and pores, showing constant change. Its greatest length of 106,000 miles was reached on 17th, then diminished, but on 21st again increased to 96,000 miles, two spotlets 71,000 miles apart remaining on 23rd and 24th. 14th to 24th.

No. 102*a*.—A minute pore on 18th, but hazy when last seen 19th.

No. 103.—A group of pores 22,000 miles long 17th, increasing to 60,000 miles on 21st, when it formed an elliptical figure. It seemed enlarging when close to the limb on 24th.

No. 104.—One spotlet on 17th, two on 19th. 17th-21st.

No. 105.—A group of pores on 18th, by 21st the members were larger and it took a wedge form, afterwards subject to rapid changes. Its maximum length was 66,000 miles. 18th to 24th.

No. 106.—Two pores 21st, increased to a group 44,000 m. long 23rd, a single spotlet 24th-27th.

No. 107.—A return of 93, solitary, 11,000 miles in diameter, slowly dwindling. 22nd to August 3.

No. 108.—A spotlet and a grey pore 30,000 miles apart 28th, just visible in early morning on 29th.

No. 109.—A spot 13,000 miles in diameter came round on 29th, heading a group which grew to 110,000 miles in length, increased by a faculic disturbance for nearly 50,000 miles farther in its rear. It contained three large spots, two of which reached a diameter of about 42,000 miles. A naked eye group. July 29th to August 10th.

No. 110.—A big spot 43,000 miles in greatest diameter, visible to the naked eye, having at times small pores close round it. July 31 to August 12.

Our chart is constructed from the observations of Messrs. J. McHarg, A. A. Buss, and F. C. Dennett, compared with drawings by Mr. A. Mee.

ASTRONOMY.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Magnetic Field in Sunspot Vortices.

PROFESSOR HALE has recently announced a most interesting and important discovery as a further result of his investigation of the vortices in sunspot areas depicted by means of the spectroheliograms taken in Hα (C) light. From the strong evidence furnished by the photographs of the existence of rotational disturbances, he was led to infer that a magnetic field should be produced, and this idea was quickly put to the test by taking special photographs of the spectrum of a large spot with large dispersion. He argued that if such a magnetic field did exist, then the light from the umbra of the spot, in passing through this field, would become circularly polarised, and that the magnetic polarisation should show as the Zeeman effect in producing doublets of certain lines. In front of the spectroscope slit a polarising apparatus was arranged to act as analyser, and both the light from the spot and comparison light from the ordinary photospheric surface were allowed to pass along exactly the same path. The spectrum was then photographed with the Nicol prism in positions varying by 45°. In the resulting spectra doublets are clearly shown, with the components alternately inverted in intensity according to the position of the Nicol, thus leaving little doubt that Professor Hale's interpretation of the phenomena is correct.

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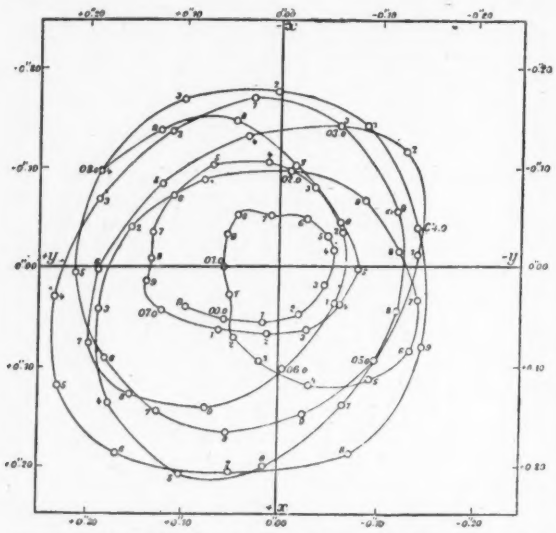
Variation of Latitude.

Further observations from the international latitude-variation stations indicate that the displacement of the terrestrial pole is during the present year being subject to a similar increase of magnitude to that observed during 1902. The observations are made continuously at the special observatories of Mizusawa, Tschardjui, Caloforte, Gaithersburg, Cincinnati, and Ukiab, situated on the same parallel of latitude + 39° 8′. From the accompanying curve published by M. Th. Albrecht, it will be seen that the oscillation



Variation of latitude, showing the displacement of the Terrestrial pole from 1900-1908. (*1″ of arc*) = *31 metres.*

was very feeble in 1900, increased considerably by 1903-4, passed a second minimum about 1905-7, and is now approaching another maximum. On the diagram, one second of arc represents 31 metres, from which we see that this oscillation of the terrestrial pole during the period of observation has not exceeded 0″.40, that is, about 12 metres.—(*Bulletin de la Soc. Astronomique de France*, p. 378, August, 1908.)

Fluorescence in the Solar Corona.

Professor R. W. Wood describes a further series of suggestive experiments on fluorescence of metallic vapours, in the course of which appearances are described which seem to have a possible bearing on the constitution of the solar corona. The presence of radially polarised light in the solar corona has always been regarded as almost proof positive that a part of its light is sunlight, scattered by very small particles. If this is so we should find the Fraunhofer lines in the spectrum, but the majority of reliable observations of the corona spectrum show that these dark lines are absent. The slight traces sometimes suspected may be explained by superposed skylight.

The recent experiments show that the fluorescent light emitted by comparatively cool metallic vapours when a powerful beam of light is passed through them is very strongly polarised, and that the percentage of polarised light is about what would be expected in the light from the corona assuming that phenomenon to be due to the fluorescence of a cloud of mixed metallic vapours surrounding the sun, under the influence of the very strong illumination to which it is subjected. When the exciting beam of light is unpolarised, the percentage of polarisation in the fluorescent radiation was about fifteen, and this was considerably increased if the exciting light was initially plane polarised.

With the dispersion which has up to the present been employed for observations of the coronal spectrum, this fluorescent spectrum of metallic vapours would appear continuous. The author quotes an observation of the corona spectrum made in 1882 by Sir Norman Lockyer, in which the spectrum was described as being distinctly ribbed in structure, caused by a series of maxima and minima of the light. Professor Wood comes to the conclusion from his experiments that the green coronium line, as well as the other bright lines, may be the fluorescent lines of some common substance.—(*Astrophysical Journal*, Vol. 28, p. 75, July, 1908.)

Paris Observatory—Report for 1907.

In his report for 1907, M. B. Baillaud, the newly appointed director, pays a special tribute to the late M. Loewy, who died so suddenly on October 15, 1907. Called to Paris from Austria by Leverrier in 1860, when he was 27 years old, his work was so satisfactory and well appreciated that he rose step by step until in 1896 he succeeded Tisserand as director. He designed the famous equatorial Coudé in 1871, which has been destined to produce such magnificent pictures of the moon, and which has since been adopted at many other observatories. His services in connection with the organisation of the *Carte photographique du Ciel* and the international observations of Eros for the solar parallax determination will for ever mark an epoch in the history of the Paris Observatory. The general work of the Observatory has been maintained as usual. With one of the meridian circles special investigations have been made on the performance of a registering micrometer, and a divided circle of platinum-iridium.

The lunar photographs taken with the Coudé equatorial for the tenth volume of the Lunar Atlas have been selected and reproduced, and it is considered that with the issue of two more volumes the series may be completed. During the year 579 new plates of the moon were obtained. A number of experiments on solar photography have also been made with this instrument. M. Nordmann has continued his series of stellar photometric determinations, in the course of which he has obtained evidence of the dispersion of light in celestial space, and of special phenomena in connection with certain double stars, β Lyrae, δ Cephei, etc. In the department of astronomical physics, the new stellar spectroscope has been employed with the great equatorial Coudé. The instrument is of the auto-collimating or Littrow type, having an aperture of $0^m.09$ and focal length of $2^m.50$. Three different degrees of dispersive power are provided by means of light flint prisms of different angles. The strongest has a refracting angle of 60°, giving a dispersion of four Angstrom units to the millimetre at Hγ (4341). The first work to be done is the determination of radial velocities of bright stars. From a preliminary series of forty spectra, it is found that the spectrum of Arcturus can be obtained in 45 mins., when the conditions are good.

The photographic equatorial has been employed in obtaining 40 further plates for the Chart, 3 plates for the Catalogue, and in special plates for the study of the globular cluster M 53 and the variable star S.W. Herculis. All the reproductions and reductions of plates for the Catalogue have been well advanced during the year.

M. Gonnessiat, astronomer of the 1st class, was appointed in November to the directorship of the Algiers Observatory, vacant by the death of M. Trépied.

BOTANY.

By G. MASSEE.

Hops.

IN Bulletin No. 50, *Bureau of Statistics*, U.S.A., an account is given of the supply of hops from the principal countries. This has been suggested by the shortage in the world's supply of hops, which has been made apparent since the gathering of the crop of 1906. The United States is said to be capable of supplying the world with hops, however greatly the demand may increase, if the prices of the world's markets offer sufficient inducements.

At present the United States is one of the three leading hop-producing countries of the world. Until somewhat recently, New York was the principal hop-growing State,

but at present more than 60 per cent. of the hops of the United States are grown in the Pacific Coast States.

Hops are a localised crop throughout the world; only a few countries grow large quantities of hops, and these generally in special districts only.

Austrian hops are grown almost entirely in Bohemia. These are held in high esteem, and command high prices. Only female plants are grown in the fields, to secure a hop without seed. Men are specially trained, and the quality of the hops is guaranteed, the result being Austrian hops have a world-wide reputation.

In Germany hop production is not so localised, and the fields are often small. The hops are gathered by the farmers and dried in the sun, then shipped to central points where they are further dried, the result being hops of very fine quality. This method has solved the labour and drying problems.

Belgium and France produce only small quantities of hops.

The yield of hops grown in England is higher than on the Continent.

More than 90 per cent. of the exports of hops from the United States are destined for Great Britain. Nearly one-half of the hops imported into Great Britain come from the United States, hence the fluctuations in trade are said to depend upon the production of the two countries, a shortage at home increasing the exports from the United States.

The Continental people are more particular about the quality of the hops used for their beer than the English, hence up to the present American hops have not been able to gain much of a foothold on the Continent.

Belgium, including re-exports, ranks next to the United States in providing Great Britain with hops. The quality of Belgian hops is said to be much below that of the hops of Germany and Austro-Hungary.

Much detailed information bearing on hops, brewing, etc., is contained in the Bulletin quoted.

The Value of Certain Nutritive Elements to Plant Cells.

Mr. H. S. Reed has recorded the results, in *Ann. Bot.*, of a series of studies bearing on the influence of various metallic elements on the growth of the cells of algæ, the protonema of mosses, the prothallia of ferns, and of root-tips in culture solutions.

The essential elements either become integral parts of some or other of the cell constituents, or they act indirectly in promoting certain chemical or physical changes. When abnormal nutritive conditions were induced no morphological changes were presented by the protoplasm, the non-living portions of the cell, as starch, cell-wall, etc., alone responding and becoming more or less modified.

K is essential for the formation of starch and mitotic cell-division; its absence acts also injuriously on fungi.

The absence of P is yet more detrimental to growth, as the transformation of carbohydrates depends on its presence.

Ca is necessary for the growth and subsequent functions of chloroplasts, and although mitotic division occurs in its absence, the cell-walls remain imperfect.

Mg is also necessary for the functional activity of chloroplasts. Oil was not formed by *Vaucheria* in its absence.

Effect of Electricity Upon Plants.

Mr. J. H. Priestley enumerates, in the *Bristol Nat. Soc. Proc.*, certain experiments made by Mr. J. E. Newman with a view to determine the value of electricity on crops, from a practical standpoint.

In 1904, 500 square yards of kitchen garden were electrified by the overhead discharge system, and compared with controls, gooseberries yielded 17 per cent. increase; strawberries 36-80 per cent. increase; tomatoes, no beneficial result.

In another plot, carrots yielded 50 per cent. increase and beets 30 per cent., with an increase of 1 per cent. sugar content under similar treatment.

In 1906, twenty acres of wheat were treated with discharge wires at a considerable height, and a very high tension current; the increase over control was 39 per cent. The electrified wheat gave a better quality of flour.

Laboratory experiments to determine in what particular manner electricity acted favourably on plant growth were without result.

Pollacci's statement that an electric current enables leaves to form starch in darkness was not confirmed.

Stellaria Aquatica.

Miss E. M. Hodgkinson records the discovery of *Stellaria aquatica* from the bank of the Rother, at Midhurst, in Sussex. In Bentham and Hooker's "British Flora," it is stated, "this species is not found south of Yorkshire and Cheshire." This is an unfortunate slip, and north was intended instead of south. The plant in question is not uncommon in several southern counties.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

Permanency of Pigments.

A CORRESPONDENT has recently sought my advice as to the possibility of preventing the fading of the pigments with which the silks and wools used in embroidery are dyed. Unfortunately, there appears to be little hope of protecting ordinary pigments against the ultimate bleaching action of light and air, and all that can be done is to select the most resistant pigments, and to keep them under such conditions as to minimize the inevitable atmospheric influence. No aniline dyestuff, for instance, can make any claim to permanency, as may easily be proved by exposing a surface coloured with one of them under a negative in an ordinary photographic frame. And there are numerous instances in which valuable typewritten documents have completely faded out in a few years.

A most instructive report upon the permanency of various water-colour pigments was issued in 1888 by the Science and Art Department, in which was summarised the results of the experiments made by Dr. Russell and Sir W. Abney upon this point. In each case a wash of eight tints was applied to paper of the same size and quality, and the slips enclosed in glass cylinders, so arranged that free circulation of air took place, while dust was excluded. After two years many of the pigments had changed materially in depth of colour, the most fugitive including carmine, purple madder, indigo, gamboge, cadmium yellow and sepia, while burnt sienna, chromium oxide, Prussian blue, cobalt, and ultramarine were the most stable. When exposed to the action of moist air very few of the pigments remained unaffected, and none of those of organic origin, while the Prussian and Antwerp blues were completely destroyed. In a later series of experiments the strips of paper were thoroughly dried, and sealed up in the tubes after removal of the air as completely as possible by means of an air-pump, and the tubes then exposed to the light as before. Under these conditions most of the colours remained unaffected, though there was an almost imperceptible change of shade in the case of vermilion, raw sienna, Prussian blue, purple madder, and sepia. Obviously such stringent exclusion of atmospheric oxygen and moisture from pigments is not possible under ordinary conditions, though it would seem quite practicable to keep any coloured object which it was wished to expose to the light, in a glass case which had been first thoroughly dried and then closed in such a way as to render it perfectly air-tight and proof against the admission of any moisture.

In the case of oil-paints the varnish with which the pigment is incorporated affords considerable protection against moisture and other atmospheric influences, and accounts for the much greater stability of oil-paints than of water-colour pigments. Yet even with oil-paintings there may be a very rapid deterioration of the pigment under the influence of light and air, as was shown by the experiments of Professor Church, in which different oil-paints were exposed under similar conditions for periods of two to five years No change was perceptible in the case of Naples yellow, madder red, and artificial ultramarine, but the other pigments tried

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had either changed slightly in colour or intensity or both, whilst crimson lake had almost completely faded.

Nipponium: A New Element.

Although many of the predictions of Mendeleef as to the existence of unknown elements to take the vacant places in his periodic system have been fulfilled, there are still numerous gaps that require filling. Of the predicted elements many have been discovered in association with the so-called rare-earth metals, and this is also true of an element which Mr. Ogawa has found in minute proportion in thorianite, reinite (a tungsten ore), and molybdenite. The name *nipponium* and the symbol Np are suggested for this element, which is a metal apparently allied to aluminium. It appears to form salts in two states of oxidation, though it has not yet been found possible to obtain well crystallised salts. Its basic oxide is precipitated with alumina in the ordinary method of analysis, but can be separated from it by conversion into an anhydrous chloride. Nipponium has an equivalent weight of about 50, and in the opinion of its discoverer its place in the periodic system probably lies between molybdenum (atomic weight = 96), and ruthenium (atomic weight = 104).

GEOLOGY.

By EDWARD A. MARTIN, F.G.S.

How "Worm-Tracks" may be Formed.

IN experimenting with some chalk puddle brought from a Sussex dew-pond, I noticed that as the material dried it became scored with what appeared to be cracks upon its surface. The strange thing about these cracks was that each one terminated somewhat abruptly. Whilst watching the drying puddle, I noticed a movement at the end of some of the cracks, and I found that each crack had been caused by a fresh-water bivalve in making its progression along the surface. At every movement it advanced about one sixteenth of an inch, leaving this crack-like trail behind it. This in interesting geologically. In many of the rocks which are almost unfossiliferous, tracks are sometimes seen which are called worm-tracks, and the tracks which I have described might well have been regarded as worm-tracks, were it not that I observed the actual making of them by a mollusc.

Klondyke Gold.

Mr. R. M. McConnell's report to the Geological Survey of Canada in regard to the Klondyke region shows that he estimates the gold already produced at the value of £18,950,000, with nearly 11 million pounds' worth remaining to be gathered, so far as the discoveries go which have already been made. Further discoveries may, however, prove the latter estimate erroneous.

Chalk off the Eddystone.

The dredgings made in the English Channel, particulars of which have been recorded in the Marine Biological Association's Journal, have resulted in a discovery of chalk under the sea south of the Eddystone Rock. With the information at hand, it is not easy to say of which flexure this development in the west may be a continuation. It may possibly be a westerly extension of the plateau which extended south from the chalk backbone of the Isle of Wight to some point in the sea undetermined. The dredgings constantly brought up flints from the mid-Channel beds, and it is by means of the westerly tidal wave that these are the source of a never-failing supply of gravel on our southern coasts.

Radium and Geology.

It is announced that the subject of the connection between radium and geological speculation will form the subject of Professor J. Joly's presidential address to the Geological Section at the meeting of the British Association in Dublin.

Dene-Holes.

The subject of dene-holes is one over which controversy will always rage. Were they underground hiding-places? Did their makers live in them? Were they merely mined for chalk or flint? Were they places for worship? Were they granaries? The last-mentioned is favoured by Mr. A. J. Philip, in the *Reliquary*, and there is much evidence in support of this theory. Possibly with the discovery of fresh dene-holes elsewhere than in Kent, Essex, or Sussex, further light will be thrown upon the subject. So far as my opinion goes, one thing seems clear, namely, that they were not simply chalk or flint mines.

Holes on Wolstonbury Hill.

The ancient earthworks on Wolstonbury Hill, on the South Downs, are on an extensive scale, and the area enclosed is pitted with excavations more or less shallow, which may be attributable, in some cases, to the flint-implement workman in search of flint. Some of the pittings are regular in shape and not always circular, and suggest the sites of neolithic dwellings, or perhaps guard-houses. But in these matters it is very difficult to arrive at a legitimate conclusion, where so much is left to the realms of speculation. The hill has a covering of red loamy soil, much thicker than is usually found on the South Downs, and it is difficult to think that the excavations were made in search of flint when the chalk is so well exposed on the flanks of the hill. A disused and almost invisible road on

Wolstonbury Hill from Clayton Mills.

the west side of the hill has three of these small pits in the middle of the track, and their position raises an interesting question. Were the pits or the road there first? I suggest that the pits are true swallow-holes which have developed in the track of an ancient road. If these are swallow-holes, then the so-called excavations higher up the hill may in some cases be swallow-holes also, and this would account for the otherwise perplexing number of the pits. Many of them have a distinct resemblance to the swallow-holes in Farnham Park. The underground flow of drainage water under this extensive hill would, I think, be sufficient to dissolve and carry off a large amount of chalk in solution, and may account for the comparatively great thickness of the clay-with-flints above it.

The Merrivale Avenues.

The famous Merrivale avenues of prehistoric stones are threatened with interference by a light railway which is to be constructed on Dartmoor. Apparently the railway will run through the various groups of stones, although it is provided that it shall not be nearer than 200 feet from the Menhir. I should like to add my strong protest against this spoliation of the whole area. The protection of the avenues seems to be a matter for the County Council to undertake, towards which they are now empowered by law to make a contribution. Perhaps the Selborne Society will move in the matter.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

Composition of Air at Great Altitudes.

MONS. LEON TEISSERENC DE BORT, of Paris, contributed a very interesting paper to the July number of the Quarterly Journal of the Royal Meteorological Society, describing his researches on the composition of air at great altitudes, with special reference to argon and its allies. He says :—

"The attention of men of science has long been directed to the question of the composition of air at various heights in the atmosphere, and from the time of the first employment of *ballons-sondes* by Hermite and Besançon, several attempts have been made to collect air from great heights by means of apparatus designed by M. Caillete, and one of these was successful. The quantity of air obtained was almost two litres, and it was analysed by M. Muntz, who found argon present in the normal proportion.

"The existence of an isothermal layer in the atmosphere was discovered some years ago by our work with *ballons-sondes*, and has been demonstrated also in the region of the tropical Atlantic by the cruise of the *Otaria*, and under the Arctic circle by our Franco-Swedish expedition. The idea suggested itself to some people that this phenomenon of the stoppage of the diminution of temperature might be accounted for by some distinct difference in the composition of the air at high altitudes. Although I did not myself share this view, and had suggested a dynamical explanation of the isothermal layer, it seemed to me to be none the less interesting to investigate the composition of the upper air. My explanation was based upon the absence of vertical movements accompanied by adiabatic expansion in the isothermal layer, and thus tended to represent the portion of the atmosphere as having an individuality of its own, and not being mixed up by the vertical movements of cyclones and anticyclones, which tend to make the composition of air uniform by constant agitation in the lower and middle layer of the atmosphere. Thus if there is any difference in the composition of air with altitude, it should be accentuated between the isothermal layer and the portion of the atmosphere on which that layer rests.

"As the *ballons-sondes* now in use are much smaller than Hermite and Besançon's aerophile, which was an expensive structure of gold-beater's skin, it was necessary to utilise very small vessels for securing the samples of air from a great height. I accordingly set to work to devise a vessel which should confine the air with absolute security, dispense with stop-cocks [the automatic closing of which is difficult on account of the very low temperature of the high atmosphere], and which should enclose the sample of air at a perfectly definite height. Electricity was the agent employed. The collecting vessel was a glass tube with a finely drawn-out end, which was sealed after a very perfect vacuum had been made inside. When the tip of the capillary tube was broken at the desired height the air was expected to enter readily, and fill the tube so that it only remained to fuse the capillary tip in order to secure the sample. The tube is opened by the tip being broken off by the fall of a little hammer, released by an electric contact, and it is sealed by another contact allowing the current from a small accumulator to raise to red heat a platinum wire wound round the capillary tube, by which means heat is produced sufficient to melt the glass. Both contacts can be made either by the barometer at a pressure previously arranged, or by the clock-work of the meteorograph, and the whole operation is so conducted that no impurity can possibly affect the air in the tube, the apparatus being hung at such a distance below the balloon that there can be no trace of hydrogen in the air.

"The apparatus, as first made on a very small scale, secured several little tubes of air in July, 1907. I supplied several similar pieces of apparatus to the *Otaria* for use on the Atlantic; but the presence of salt in the sea air seems to have affected the contacts and they did not act properly.

"I pass over the various practical difficulties which presented themselves, and which have not yet been completely overcome. The very narrow limits of size and weight within which one had to work made the arrangements somewhat difficult, for it was necessary to use a very light accumulator and a very light glass receiver, which had also to be surrounded by a covering sufficiently strong and well hung to obviate the risk of breakage when it came to the ground.

"The quantity of air collected was too small to permit of an ordinary chemical analysis, and I accordingly decided to confine myself to spectrum analysis, paying special attention to argon, neon, and helium. I have proceeded by two different methods; one, by absorbing all the elements of the air except helium and neon by means of carbon; the other by first separating the argon.

"The result of the first experiment has proved the presence of argon in all the samples of air taken between 8,000 and 14,000 metres (5 to 8 miles) as one would expect. Helium, distinguished by its yellow line in the spectrum, has been detected in most of the specimens, but the highest of all, that taken at 14,000 metres, showed no trace of it. Neon was clearly discernible in every case. The attempts to disclose krypton have not as yet given any result, but the experiments on this gas are not sufficiently numerous to permit of forming an opinion on the subject.

"So far there has been no question of quantitative analysis, the volumes of helium and neon being so infinitesimal that it will be necessary to increase considerably the quantities of air collected, or to carry the technique of the operations still nearer to perfection before a quantitative result can be arrived at."

ORNITHOLOGY.

By W. P. PYCRAFT, F.L.S., F.Z.S., M.B.O.U., &c.

The Cumberland County Council and Bird Protection.

WE cannot congratulate the Cumberland County Council on the changes which have just been made in the Bird-Protection Orders for the county. Most unwisely, and without adequate reasons, they have struck off the black-headed gull from the list of birds whose eggs are protected; furthermore, this very useful bird may now be shot in the close season. Yet another unfortunate blunder has been made in removing the common buzzard from the list of protected birds.

While County Councils have to depend on the advice of irresponsible and ill-qualified advisers this haphazard, leap-in-the-dark legislation will continue. Some day, perhaps, the Board of Agriculture will awake to a sense of its responsibilities and take over the whole control of bird protection. Then, and not till then, shall we know what measures of protection are necessary, and how these should be applied.

The Destruction of Quail in the Breeding Season.

Colonel Momber, in the *Field* (August 8), raises a timely protest against the traffic in quails for table purposes which is carried on in this country. The mortality which their capture entails is enormous, for besides those strangled in the nets, and rendered useless for sale, an appalling number die on the journey to England. Since their transit by rail through France, Switzerland, and Germany during the close season is illegal they have perforce to be sent to England by sea. As might be supposed, the mortality during the voyage is great, and the stench from the canvas-covered boxes of dead and living birds is overpowering enough to "deter some passengers from sailing by the steamers carrying large consignments of quail." The birds, which are eventually slaughtered in London, form but a small fraction of those netted in Egypt and Tunisia; that is to say, vast as is the number which arrive in London, a still larger host are absolutely wasted. Agriculturally, the quail is a most useful bird, and on this account surely demands protection. As Colonel Momber remarks:

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"Surely it is time to end this cruel traffic in caged birds during the breeding season, a practice discreditable alike to British civilization and British sporting prestige. Even in Italy, where the killing and eating of small birds seem to be the national pastime, and where the 'caccia' is specially kept open for quail shooting until June 1 along the sea-board, the birds are granted immunity from being killed or marketed during the rest of the summer."

Wood-Pigeon Diphtheria.

Those interested in the history of that virulent scourge, wood-pigeon diphtheria—and who is not?—should read the able article thereon by Mr. C. B. Ticehurst in *British Birds* for August. His report will inspire confidence, since he writes not at second-hand, but of his own investigations, which he has been carrying on for some months past at Guy's Hospital, London, by way of a relief from other work.

It has been stated, more than once, that pigeon diphtheria is communicable to man. For this belief Mr. Ticehurst can find no evidence, but he regards it as certain that it may be transmitted to other animals. It would appear, however, to be by no means easily spread. And in support of this he quotes the case of an estate whereon 4,000 wood-pigeons were destroyed last winter, and where 3,000 head of pheasants are shot every year. Yet no case of "diphtheria" in pheasants was met with.

Black-Tailed Godwit in Kent.

In *British Birds* for August Mr. R. Sparrow describes a bird which he saw, and identified as the Black-tailed Godwit (*Limosa belgica*), on May 12 last, on a "fleet" in Romney Marsh. From his description there is no need to doubt the correctness of his identification.

Spotted-Redshank in Kent.

Mr. Sparrow in the same communication records the fact that he saw a Spotted-Redshank at the same place and on the same evening as that on which he saw the Godwit.

Pallas's Sand-Grouse in England.

Numerous records of the appearance of Pallas's Sand-Grouse in different parts of the country during the present year have been published in various magazines and journals. These have been briefly summarised in *British Birds* for August, and will prove valuable to those who desire to keep their note-books up to date.

PHYSICS.

By PROFESSOR A. W. PORTER, B.Sc.

A Tantalum Wave Detector.

A WAVE DETECTOR has recently been devised by Mr. L. H. Walter, in which tantalum is employed in conjunction with mercury. A first experimental detector was made by passing two tantalum wires, taken from an ordinary tantalum lamp, down two fine glass capillary tubes and allowing the wires to project about $\frac{1}{16}$ of an inch, and their points just to touch the surface of a small pool of mercury. Trials of this detector gave remarkable and unexpectedly good results. It was spontaneously restoring, exceedingly sensitive, and gave signals, when used with a telephone, which were notable for their loudness and pure tone. It was soon found that better results could be obtained with a single tantalum point, provided this was connected to the negative pole of the potentiometer arrangement, the best applied voltage being apparently 0.2 or 0.4 volt. In this latter form the other terminal is a platinum wire dipping into the mercury, and the whole is sealed up in a glass vessel. When properly constructed such detectors do not deteriorate—at any rate, during a considerable number of months, which is as long as they have been available up to the present. Their sensitiveness for weak signals is not claimed to be as great as either the electrolytic or magnetic detector; but for slightly more powerful oscillations the sound is several times louder than that obtained with the electrolytic, which is itself more sensitive than the magnetic detector. These results were obtained when each detector was employed with the telephone most suitable for it. Loud commercial signals have been obtained at a distance of 450 miles, the transmitter being, not one of the high-power stations, but an ordinary 2 kilowatt ship installation. The resistance of the detector is only about 1,500 ohms, and drops to from 250 to 70 ohms for very strong signals. The great loudness of the signals obtainable is due to the large change in the current through the telephone.

Discrimination Between Sounds from Different Directions.

"As already mentioned, I am now unable to make the discrimination myself, even in the case of the voice used naturally; so that all that I can report relates to the observations of others. It would seem, however, that even youthful listeners are not always able to pronounce with certainty. In experiments made with some young people in a long corridor, they were able to discriminate among themselves whether a voice came from in front or behind, but when I spoke they made mistakes. The speaker facing towards the listener gave, for example, the numerals one, two, three, etc., and there were enough assistants moving backwards and forwards to eliminate information which might otherwise be given by footsteps. Why my voice afforded less foundation for a judgment was not clear, possibly in consequence of its graver pitch, or because its quality was less familiar. The corridor was so long that the observations were not appreciably disturbed by echoes. . . . Mr. Enoch is able in many cases to discriminate between front and back when the voice is used naturally. But I find that both indoors and outside he could be deceived. Thus, when standing on the lawn only a short distance in front of him, but facing *from* him, I gave the numerals he judged that I was behind him, and this erroneous judgment was not disturbed even when I conversed freely with him. . . . Probably the turning away of the speaker softens the sibilants and other high elements in the sound, somewhat in the same way as is done by the external ears of the listener when he faces away from the sound. . . . The repetition and extension of these observations would be of interest. . . ." —(Lord Rayleigh, *Phil. Mag.*, August, 1908.)

Alpha Particles from Thorium and Actinium.

Dr. H. L. Bronson brings forward evidence to prove that an atom of thorium C in breaking up gives off the same number of α particles as an atom of thorium B; and that an atom of thorium emanation gives off four times this number; also, that an atom of actinium emanation in breaking up gives off twice as many α particles as an atom of its active deposit. The difference in the number given off in these cases raises the question as to how many are given off in the various stages of the disintegration of radium. It is usually taken that a single particle is given off in each stage. It is often assumed that the emanation fills the gap in Mendeleef's table at atomic weight 216. If it does so, more than one alpha particle must have escaped in its production from radium.

ZOOLOGY.

By R. LYDEKKER.

Fishes and Malaria.

AT the Zoological Gardens, I am informed, there has lately been received a consignment of minute fishes known in Barbados by the local equivalent for "millions," on account of the vast swarms in which they occur. Needless to say, no work on fishes that I have consulted makes any mention of the name "millions," and I should have been at a loss to know the relationship of these fishes were it not that the Secretary of the Zoological Society has kindly informed me that their scientific title is *Girardinus pœciloides*. This fish is a member of the Cyprinodont group.

To the presence of these "millions" it has been thought

that the immunity to malaria enjoyed by Barbados may be due. Some confirmation of this theory is afforded by a statement to the effect that at one of the leading hotels in Jamaica, where the water-tanks were supplied with these fish, there was a noticeable diminution in the number of fever-cases in the neighbourhood. His Majesty the King of Italy believes, indeed, so strongly in the possibility of lessening malaria by this means that he has had experiments carried out in Rome. Some hundreds of specimens were consigned to the Gardens in the Regent's Park, where they appear to flourish on the larvae of gnats obtained in profusion from the alligators' tanks. Consignments of the "millions" are, it is stated, being despatched to some of the African protectorates, where the malaria-mosquito is specially prevalent.

A New British Zoophyte.

Professor J. A. Thomson, of Edinburgh, announces the discovery in the Färoes of a large species of antipatharian coral, a group previously unknown to be represented in British waters. The specimen, which stands about a yard in height, was dredged up by a fisherman, and has now found a home in the University Museum at Edinburgh. It apparently belongs to a Mediterranean species, which has, however, been provisionally recorded from the Bay of Biscay. Its occurrence so far north as the Färoes must apparently indicate a warm current in the deep water of that area.

"The Monster of Partridge Creek."

That a living representative of the carnivorous dinosaurs of the Secondary Epoch should be living in the frozen North of Alaska seems incredible to every scientific mind, and yet, if it does not, why on earth should an apparently respectable French writer and traveller, as well as a French-Canadian priest commit deliberate perjury? I allude of course, to an article with the same heading as this paragraph, in the July number of the *Strand Magazine*. The *primâ facie* presumption is that the larger dinosaurs were inhabitants of warm rather than of Arctic zones. The creature is stated to have been seen carrying off in its mouth an animal which appeared to be a reindeer (caribou). The artist has, however, represented it with a deer, whose horns seem in some degree intermediate between those of a sambur and those of a red deer; but, then, artists generally do their best to distort zoological facts!

The Extinct Birds of Central France.

Of course, I am aware that according to the classification adopted in "KNOWLEDGE," birds do not come under the realm of zoology; while I am equally cognisant of the fact that my friend who writes the geological column in this journal considers that fossil animals come within his scope—which they do not. Neither of these considerations will deter me from devoting a paragraph to the extinct bird-remains from the lower Tertiary phosphorites of the plateau of Quercy, in Central France, which have just been fully described by Dr. C. Gaillard in a memoir published by the University of Lyons. The unfortunate thing about these remains is that they occur only as single and generally imperfect bones; associated portions of a skeleton being apparently quite unknown. This naturally enhances the difficulty of determination, although I do not for one moment suggest that the author of the new memoir is not perfectly correct in his determinations. Still, such difficulties have to be borne in mind when the extremely mixed character, from a geographical standpoint, of this bird-fauna, as determined by Dr. Gaillard, is taken into consideration.

The fauna includes over forty different species, referable to five-and-twenty genera. In addition to a number of European types, we have a raptorial bird, described as *Aquila* (?) *hypogea*, which is stated to present resemblances to the Brazilian *Polyborus*; while another member of the same group is definitely referred, under the name of *Plesiocathartes europus*, to the South American condors. Another new type, *Strigogyps dubius*, is regarded as probably, although not certainly, connecting the owls with the diurnal birds-of-prey. What my friend Mr. Pycraft, who will not admit any relationship between these groups, has to say to this, remains to be seen. The African secretary-bird is represented by two distinct generic types, *Amphiserpentarius* and *Tapinopus*. Brazilian affinities are again indicated *Archæotrogon*, a supposed ancestral form of trogon; while alongside this are a number of Indo-Malay and South European types. Finally I may allude to a genus and species originally described by myself under the name of *Ægialitis gallica*, and then regarded as a relative of the gulls. Dr. Gaillard, who had additional material at his disposal (assuming this to be rightly identified), is, however, of opinion that the relations of this species are rather with the swifts and frogmouths.

Always on the assumption that the author is correct in his determinations, the occurrence of these Brazilian types of birds in the Lower Tertiary of France makes one more link in the long chain of evidence connecting the fauna of Africa and Madagascar with that of South America.

The Astronomy of the Bible, by E. Walter Maunder, F.R.A.S. (London: Sealey Clark and Co., 1908; 5s. net).—The exhaustive study of Biblical astronomy which Mr. E. Walter Maunder has given us is profoundly interesting and beautifully written. The writer's great knowledge of his subject enables him to see in the magnificent and imposing imagery of the Bible and in the similes so frequently drawn from celestial phenomena, indications of the contemporary Hebrew conception of astronomical facts. And he interprets them with a sincerity of purpose and simplicity of style and diction that makes his book as delightful to read as one feels sure the author must have found it to write. Mr. Maunder seeks to determine how much the Hebrews of the Bible knew and understood of the great natural phenomena to which allusion is made. Beginning with the Hebrew account of the Creation, for instance, he remarks on its comparatively early date as compared with that of Babylon, and comments on its extremely primitive conception of astronomy. "The heavenly bodies are simply the greater light, the lesser light, and the stars." Mr. Maunder goes on to discuss the meaning of the word translated firmament. The Seventy in making the Greek version of the Old Testament translated the Hebrew ráqia by steréoma, thereby conveying the impression of solidity in accordance with their own conception of the universe as a series of crystalline spheres, whereas the word ráqia really signifies a stretching out or expanse, an atmosphere in effect; what we should express by the canopy or vault of Heaven. Within this expanse the Jews clearly understood the circulation of water through the atmosphere. The Prophet Amos describes Jehovah as "He that calleth for the waters of the sea and poureth them out upon the face of the earth." And still more explicitly Elihu declares that "He draweth up the drops of water, which distil in rain from his vapour, which the skies pour down and drop upon man abundantly." Mr. Maunder's intimate knowledge of Biblical literature enables him to illustrate all he says by pointed and effective quotations. Thus the "alterations of the solstices" are mentioned in the Book of Wisdom as being part of the learning of Solomon, translated in the old version as "the alternations of the turning of the sun." Mr. Maunder thinks that St. James may well have had this verse in his mind when he wrote: "Every good gift and every perfect gift is from above, and cometh down from the Father of Lights with whom is no variableness neither shadow of turning." On this passage, one of the most beautiful and suggestive in the Bible, Mr. Maunder comments: "The great modern discovery that nearly every form of terrestrial energy is derived ultimately from the energy of the sun's rays gives a most striking appropriateness to the imagery used by St. James." Most interesting are the chapters on falling stars, the signs of the Zodiac, Leviathan, and eclipses, but indeed it is difficult to instance special points of interest in a book where every chapter is pregnant with suggestion and allusion.

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

The Preparation of Microscopical Objects.

(*Continued from page* 196.)

The actual cutting of sections has been already dealt with, but a few hints as to common difficulties may be of service. Thin sections and those for serials require a rather hard paraffin, as already mentioned, and the temperature of the laboratory must be taken into account. If the paraffin has been over-heated in the embedding process not only is there a danger of charring the object, but it will cut badly, and the sections will have a tendency to break and crumble. Such breaking and crumbling is also caused by insufficient embedding. Crushing or wrinkling of the sections is due to a too soft paraffin, a dull knife, a layer of paraffin under the edge of the knife, or to insufficient tilt. A paraffin which is too soft may be cooled in water, or in winter it may be taken into a cooler room. Failing this, the only resource is to cut thicker sections, or to re-embed. Rolling of the sections is generally due to too hard a paraffin, and can often be obviated by very slightly warming the knife, by cutting in a warmer room, by reducing the thickness of the sections, or, finally, by re-embedding. A ribbon of sections not infrequently rolls just at first, but once it has started it goes on all right, especially as the knife or paraffin warms at its work. A little judicious humouring with a camel-hair pencil will often prove of service. Sometimes rolling is caused by excessive tilt, whilst a dull knife has the same tendency.

A longitudinal split or score in the section is due to a piece of grit, or to a notch in the knife edge. Varying thickness of the sections is due to a worn or faulty microtome, or to excessive hardness of the object, or again to wrongly adjusted tilt, or even to some play in the object-holder due to insufficient clamping, &c. An annoying occurrence is the sticking of the sections to the knife, either because too soft a paraffin is used, or because of some electric condition of the atmosphere.

Many sections will require flattening before being attached to the slide. This can be done by placing them in a flat basin of distilled water over a small flame and regulating the heat so as not to exceed about 37° C. The slide or cover-glass is then dipped beneath the section, and the latter held in place by a needle whilst the slide is gently lifted out. The excess of water is drained off, and the remainder removed by gentle pressure with filter paper. Blotting paper should not be used as it is apt to leave fibres on the sections. The drying can be completed by half-an-hour on a hot bath at about 35° C., after which the paraffin can be removed by increasing the heat cautiously, or by immersing the whole slide in xylol or some other solvent. Sections can be stained in bulk before cutting, or after cutting, but are best stained after fixation to the cover-glass or slide, as follows:

All slides and cover-glasses must be scrupulously clean, and even if new are best soaked in one of the strong mineral acids, then washed well with alcohol and put into methylated spirit, where it is well to keep them until required, when they can be removed and dried with a soft cloth. Touching with the fingers must be avoided. I have always found a strong hot solution of Hudson's soap nearly as efficacious as acid, and have frequently recommended its use. If the slide is not perfectly clean it will be found that water does not lie evenly upon it, and this is fatal to serial sections at least. To a perfectly clean slide such as this most sections will adhere if treated with water in the manner just mentioned, or the process may be varied by putting streaks of water on the slide with a sable brush, and then allowing the water partly to drain off or be mopped up, partly to evaporate, but it is essential that the sections should be thoroughly dry before the paraffin is removed either by heat, xylol, turpentine, or other solvent. But adherence of the sections to the slide can be ensured under all subsequent procedures of clearing, staining, etc., by means of a thin film of fixative. Mayer's albumen is made easily as follows:—

White of a new-laid egg	...	...	10 c.c.
Pure glycerine	...	...	10 c.c.
Sodium salicylate	...	...	.2 gram.

These ingredients must be shaken well together, kept in this condition for a week, and then filtered, which may take another week, and during the process the solution must, of course, be protected from dust. It keeps a long time, and even so small a quantity as the above will be found ample for a great many slides.

There are several ways of using this fixative, but the simplest, quickest, and I think the best is that usually adopted in laboratories. A clean dry slide is taken, and a minute drop of the fixative smeared over it with the ball of a clean finger, and then rubbed away until it is nearly invisible by means of another finger. The slide is then covered with a film of water, the sections duly arranged on it, and the whole then warmed to about 40° C. The warming is best done on a warm plate of metal or glass, a good plan being to get a strip of copper about eight inches long and an inch or so wide and to support it on an iron tripod with a lamp below, so that one end of the copper only is warmed by the lamp, and the other projects beyond the tripod. When a drop of water placed about the middle of the strip begins to boil the far end will generally be about warm enough for the slide or cover-glass to be placed on it, and the sections will immediately begin to flatten themselves out. The excess of water can then be drained off, the sections pressed down with filter paper, and then thoroughly dried in the manner already explained by means of a hot-air bath, or by keeping the slide at the end of the copper slip and adjusting the temperature so as not to exceed about 40° C. In about a quarter of an hour the sections should be quite dry, and a few moments longer will melt the paraffin around them, or it can be removed by immersing the slide bodily in xylol or turpentine. Xylol is the best for this purpose, as liquids such as benzole and chloroform are rather volatile.

The sections can now be stained, and this brings us to the final branch of our object. It may be noted, however, that one defect of the albumen method of affixing sections is that, thin though the film is, it is apt to stain somewhat with certain stains, such as eosin.

(*To be continued.*)

The Study of Minute Structure.

Mr. E. M. Nelson recently contributed to the Royal Microscopical Society a note on the secondary structure to be found in the primary areolations of *Biddulphia Mobiliensis*, a diatom well-known to students of these exquisite forms. Not infrequently one hears depreciation of the man who interests himself in diatoms, as one who has no interest in nature beyond the resolution of the most difficult structure and the most attenuated markings, but I question if any study has indirectly done more to bring about that improvement in objectives which gives us such advantages over the keen workers of a generation or more ago, and incidentally I think not a few of these diatomists could open the eyes of many a laboratory-trained worker with the microscope, who would be astonished if he were told that he had anything still to learn concerning the use of his instrument, perhaps even that he scarcely understood its elementary principles. Mr. Nelson, who has done so much for microscopy, utilises frequently the ghost-like finer markings of certain diatoms, and in his note on this *Biddulphia*, he speaks of striae which measure 32,000 and 41,000 to the inch, and which can therefore be easily resolved with any lens of moderate aperture under far from perfect conditions of illumination and adjustment, but within which are finer markings requiring a large axial solid cone of illumination, a nearly monochromatic blue-green screen, and a magnification of 2,000 diameters. With all this the structure is so delicate that it is not possible to hold the image for long at a time, not even long enough to draw. "The eye has repeatedly to be rested to get even a momentary glimpse of this tenuous structure." It is evident that the skill required to glimpse such structures is of a very different order to that of the man who uses his microscope merely as an instrument to be used empirically and without knowledge of its underlying principles, and that it would be of the utmost service to research men, who, dealing, for instance, with cytological problems, require to get the utmost resolving and defining power out of their microscopes.

Mr. Nelson adds an interesting note with reference to the much debated and still undetermined advantages of the short and long tube for microscopes. He says: "The subject is of some interest to microscopy, as these secondaries have only been seen with the long-tube microscopes, and it is very probable that this resolution will never be reached by a short-tube microscope. It has often been asked, which is the better instrument of the two? A decisive answer can at once be given to this question. If the instrument is required for the examination of the most minute structures, the long-tube is the better; but if it is required for other things, such as portability or cheapness, then a short-tube may be preferable. But so long as a microscope is employed for the highest purpose, such as the revelation of the minute unknown, then a long-tube has no rival. *The ultimate appeal* [the italics are Mr. Nelson's own] *concerning any minute structure must go to a long-tube microscope.*"

Manchester Microscopical Society.

Writing in August it seems hard to be reminded of the coming winter, but the winter months will come soon none the less, and the Extension Section of the Manchester Microscopical Society have already sent me their list of lectures for the ensuing session. For some years past I have called attention to the admirable endeavours made by this Society to extend its influence beyond its own membership, by sending out willing missionaries to the surrounding districts to teach of the beauties and interests of Nature, and incidentally to gain converts for her study. The lectures, unless given before profit-making or rate-supported undertakings, are given free (save for out-of-pocket expenses) to any Society in the Lancashire and Yorkshire district which asks for them. There are fourteen lecturers, all members of the Society, and the list of lectures numbers 47, and ranges from "marvels of the minute," as seen through the microscope, through "Darwin and Evolution," to "Prehistoric Man." The lectures are illustrated by lantern slides, specimens, or demonstrations, as required. The Honorary Secretary is Mr. R. Howarth, 90, George Street, Cheetham Hill, Manchester.

Microscopical Pamphlets.

Mr. Edward A. Martin, F.G.S., the Geological Editor of "KNOWLEDGE," has been good enough to send me a number of pamphlets, reprints of communications to the Royal Microscopical Society by the late H. J. Slack, Secretary R.M.S., which have recently come into his possession, and which he thinks may interest some of my readers. There are about 20 copies of a paper "On Some Recent Investigations into Minute Organisms" (1871), and about 10 copies of papers on "Bastian and Pasteur on Spontaneous Generation" (1876); "The Patterns of Artificial Diatoms" (1870); "Notes on the Use of Mr. Wenham's Reflex Illuminator" (1875); and on "The Supposed Fungus on Coleus Leaves," also notes on "*Podisoma fuscum* and *P. juniperi*" (1872), as well as a few odd copies of papers on the "Optical Appearances of Cut Lines in Glass" (1871); and "On the Visibility and Optical Aspects of Hairs Viewed from a Distance" (1878). I shall be glad to send any of the above to any reader who cares to apply for one, if he will mention his preference, or give me a list of two or three in order of preference in case the supply should be exhausted. It will only be necessary to enclose with the application a stamped and addressed half-penny newspaper wrapper, and the coupon to be found in the advertisement columns of this issue of "KNOWLEDGE."

Notes and Queries.

Cleaning Contents of Fishes' Stomachs.—Mr. Fred B. Taylor kindly writes in answer to the query on this subject in the last issue of "KNOWLEDGE" that on page 17 of the Journal of the Quekett Microscopical Club for 1884, Mr. Kitton gives directions for the preparation of the contents of the stomachs of oysters and other Mollusca, and that this might be applicable to the contents of fishes' stomachs. He also refers to Griffith and Henfrey's Microscopical Dictionary, 4th edition, 1883, p. 230, see Diatomaceae and Guano. Also a paper by J. A. Tulk, in the Transactions of the Microscopical Society of London, Vol. XI., 1863, p. 4.

P. J. Nottingham.—With regard to the real nature of the facets in the compound eyes of insects, I can only refer you to the notes recently published in these columns, and to Mr. Spitta's communications to the Quekett Club. I have not heard of any more recent work.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

XUM

The Face of the Sky for September.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.14 and sets at 6.46; on the 30th he rises at 6.1 and sets at 5.40.

The Sun enters the sign of Libra on the 23rd at 11 a.m., when autumn commences.

The equation of time for sundial purposes is negligible on the 1st and 2nd, hence these dates are convenient for the adjustment of dials, as only the longitude correction is needed.

Sunspots may usually be observed on the Solar disc; at the time of writing four conspicuous groups are visible.

The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Sept. 2 ..	21° 30′E	7° 13′	5° 13′
,, 7 ..	22° 40′E	7° 15′	299° 11′
,, 12 ..	23° 42′E	7° 13′	233° 10′
,, 17 ..	24° 34′E	7° 9′	167° 9′
,, 22 ..	25° 17′E	7° 1′	101° 10′
,, 27 ..	25° 50′E	6° 50′	35° 10′

THE MOON:—

Date.	Phases.	H. M.
Sept. 3 ..	☽ First Quarter	8 51 p.m.
,, 10 ..	○ Full Moon	0 23 p.m.
,, 17 ..	☾ Last Quarter	10 33 a.m.
,, 25 ..	● New Moon	2 59 p.m.
Sept 9 ..	Perigee	7 48 p.m.
,, 22 ..	Apogee	0 0 noon.

OCCULTATIONS.—The following are the particulars of the only naked eye star occulted before midnight and visible from Greenwich:—

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.
			p. m.		p. m.	
Sept. 9	τ^2 Aquarii	4.3	7·56	92°	8 56	224°

THE PLANETS.—Mercury (Sept. 1, R.A. 11h 23m; Dec. N. 5° 11′. Sept. 30, R.A. 13h 56m; Dec. S. 14° 26′) is an evening star in Virgo, setting about half an hour after the Sun throughout the month. The planet is thus not well placed for observation.

Venus (Sept. 1, R.A. 7h 39m; Dec. N. 17° 52′. Sept. 30, R.A. 9h 35m; Dec. N. 13° 35′) is a brilliant object in the morning sky, and is situated in Cancer. On the 14th the planet rises at 1.24 a.m., or four hours in advance of the Sun. On this date also she is at greatest Westerly elongation of 46° 2′. As seen in the telescope, the planet presents the appearance of "half-moon"; whilst the apparent diameter is about 24″.

Mars (Sept. 1, R.A. 10h 30m; Dec. N. 10° 38′. Sept. 30, R.A. 11h 39m; Dec. N. 3° 27′) is a morning star on the confines of Leo and Virgo, rising at 4.47 a.m. on the 15th. The planet is a feeble object and ill placed for observation.

Jupiter (Sept. 15, R.A. 10h 12m; Dec. N. 12° 1′) is a morning star in Leo rising at 3.30 a.m. on the 15th.

Saturn (Sept. 1, R.A. 0h 37m; Dec. N. 1° 5′. Sept. 30, R.A. 0h 29m; Dec. N. 0° 13′) is an evening star in Pisces and a very conspicuous object in the S.E. portion of the sky in the evening, when the planet may be seen shining as a bright star, free from scintillation and not very high above the horizon. The planet is in opposition to the Sun on the 30th, hence, near this date, is due South about midnight. The apparent diameter, and hence the brightness, is a maximum this month, being 18″, whilst the diameters of the major and minor axes of the outer ring are 45″ and 5″ respectively, thus as seen in the telescope the ring appears slightly open, being inclined to our line of vision at an angle of 7°, the Southern surface being visible. In a 3-inch telescope the ring should be visible with a power of about 50 and the belts on the planet's surface with a power of about 80.

Uranus (Sept. 15, R.A. 18h 56m; Dec. S. 23° 14′), though rather low down in the sky, is fairly well placed for observation during the early evening and is due South shortly after dusk. The planet is situated in Sagittarius in a part of the sky devoid of good reference stars, though the star ξ^2 Sagittarii is some 2° to the N. The planet is at the stationary point on the 22nd, after which his motion is direct or Easterly.

Neptune (Sept. 15, R.A. 7h 12m; Dec. N. 21° 38′) rises about 11.30 p.m. near the middle of the month, and hence is not in a favourable position for observation before midnight. The planet is situated about half a degree South of the star δ Geminorum.

Minima of Algol occur on the 13th at 11.42 p.m.; and on the 16th at 8.31 p.m.

Mira (o Ceti) is due at maximum early next month. Observations should be made to determine its increase in brightness.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—ζ Ursæ Majoris XIII.h 20m, N. 55° 25′, mags. 2, 4; separation, 14″·4.

ζ Aquarii XXII.h 23m, S. 0° 35′, mags. 4, 4; separation 3″·2. Both components are yellowish.

β Cygni XIX.h 27m, N. 27° 46′, mags. 3, 5; separation 34″. The brighter component is yellow, the other blue; very easy double in small telescopes with a power of 20.

Cluster (M 11) in Aquila or Antinous. R.A. 18h 46m; Dec. S. 6° 23′. Very pretty object for 3 or 4 inch telescope; it is an easily resolvable fan-shaped cluster, with an 8th magnitude star in apex and an open pair of the same magnitude just outside it.

DR. EDMUND OTIS HOVEY has returned to the American Museum of Natural History after an absence of three months in the West Indies. The principal points visited by him were the islands of Martinique, St. Vincent, Guadeloupe, Grenada and Barbados, in all of which he made collections for the museum supplementary to those previously obtained by him. He was particularly fortunate in securing photographs showing the changes which have taken place during the last five years in both of the active volcanoes, having camped out on Mt. Pelé for ten days and on La Soufrière for five days. Temperature observations on the fumaroles were made, including pyrometer observations on the high-temperature vents of the summit of the new cone of Pelé, where a heat of 959° F. was found. No dust or débris is being discharged at Pelé, although there is abundant and vigorous steam action. The Soufrière of St. Vincent is absolutely quiet. The bottom of the crater is now occupied by a beautiful lake, which is apparently as large as that for which the volcano was famous before the eruptions of 1902-3.